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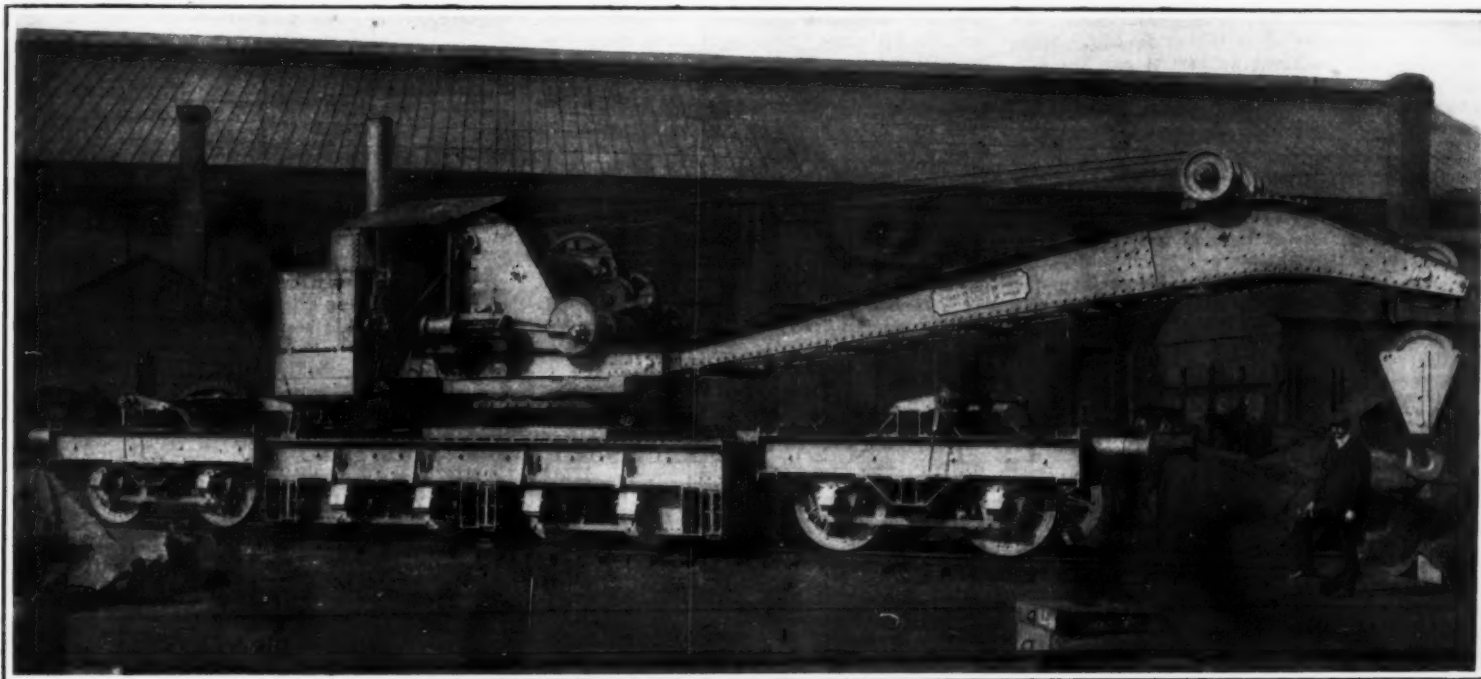
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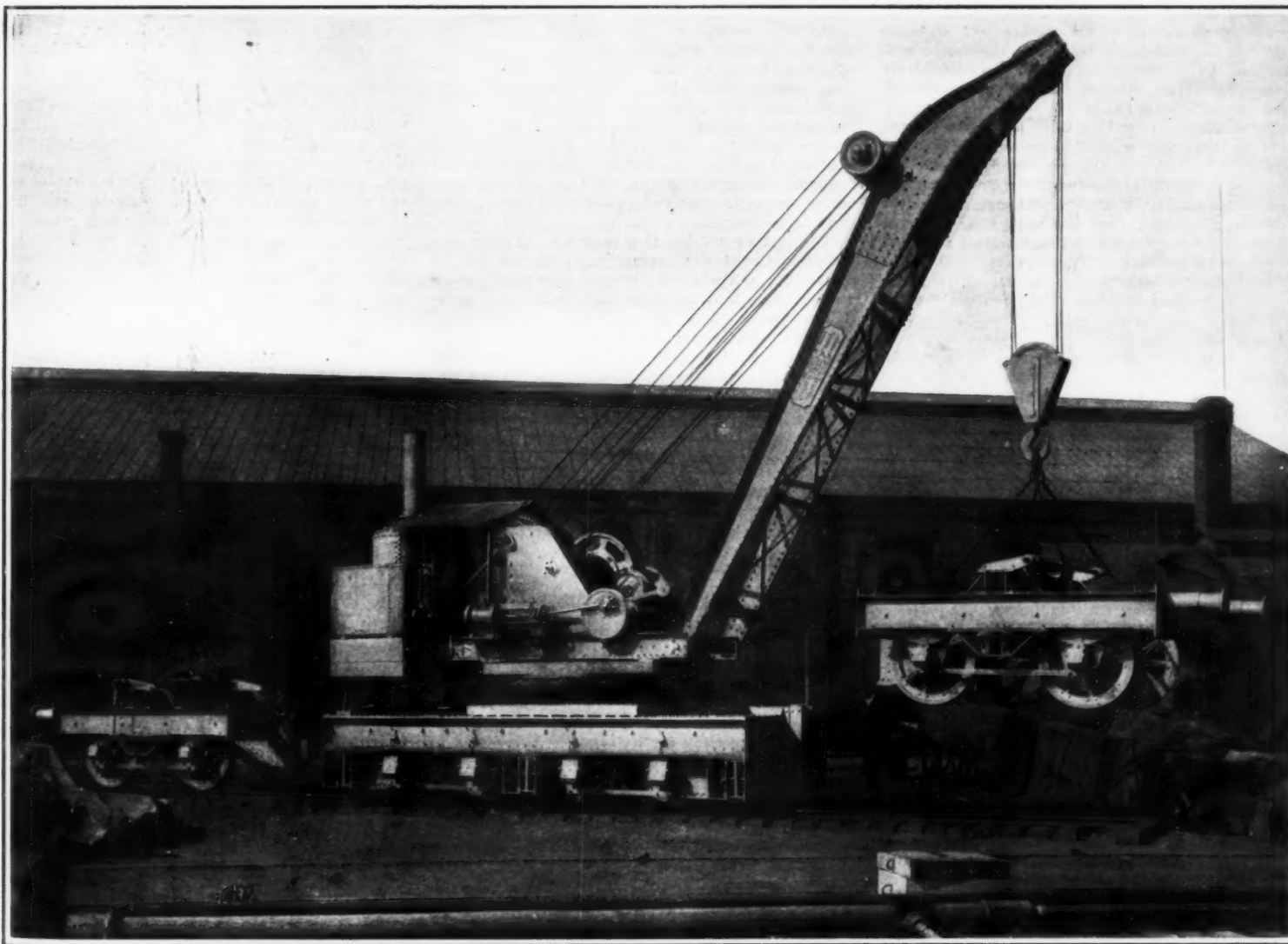
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THE EXTENSION BOGIES AT EACH END OF THE CRANE CARRIAGE.



THE CRANE LIFTING ITS FRONT EXTENSION TRUCK OUT OF THE WAY.
AN ARTICULATED RAILROAD BREAKDOWN CRANE.

AN ARTICULATED BREAKDOWN CRANE.

AN EXTENDED WHEELBASE FOR HEAVY MACHINERY.

BY THE ENGLISH CORRESPONDENT OF THE SCIENTIFIC AMERICAN.

OWING to the increased weights of railroad locomotives and cars, demand has arisen for heavier cranes for breakdown purposes. But to increase the weight of the crane in order to secure improved hoisting capacity is attended with a certain amount of difficulty, since the concentration of weight imposes an abnormal strain upon bridges, many of which are not sufficiently strong for the purpose. To overcome this difficulty a crane has been evolved by Mr. Wilfred Stokes, of London, the scope of which is a temporary extension of the wheel base of the crane, together with the number of wheels over which the weight of the appliance can be more satisfactorily distributed. The general design of this crane may be gathered from the accompanying illustrations of an apparatus which has recently been constructed for the Great Indian Peninsula Railroad.

As will be seen, the carriage carrying the crane proper is provided at either end with a small bogie truck equipped with a detachable articulated relieving girder, which is coupled to the crane carriage by means of a pin. There are special arrangements for transferring some of the load of the crane onto the bogie by means of this relieving girder easily and quickly. The fitting does not increase the rigid wheel

base of the crane carriage proper, since the bogie is free to swivel about the pin by which it is linked to the headstock of the crane truck, while the relieving girder itself can also move laterally about the pin. This insures great flexibility, especially for the negotiation of sharp curves. Upon arrival at the point where the crane is desired to work, either for hauling away wrecked rolling stock or lowering or removing the members of a bridge, the extended wheel base is quickly removed by the withdrawal of the coupling pin, and the bogies themselves are slung out of the way by the crane itself, there being slings for this especial purpose. The bogies can either be placed upon another track or temporarily deposited in any other convenient spot. Thus the crane is left free to work under ordinary conditions, the weight of the crane being such as to give the necessary stability for handling the loads for which it has been designed.

The relieving girders are carried by the bogies in such a manner as to be moved easily, either vertically or horizontally, so that the joint pin can be quickly inserted, connection or disconnection of the relieving girder only occupying from three to four minutes.

The crane shown in the illustration, which is the first of its type, is designed to work upon a railroad

gage of 5 feet 6 inches. The capacity is 20 tons at 19 feet radius, propped up, 11 tons at 19 feet radius, and 15 tons at 11 feet radius unpropped. The crane truck is mounted upon eight wheels, each of 3 feet diameter, while the extension bogies are each four-wheeled, 3 feet 7 inches diameter. In the case of the crane itself the weight imposed upon each of the axles is 16.25 tons, representing nearly 5 tons per foot run of its 13 feet 3 inches wheel base. When the bogies are attached, increasing the wheel base to 40 feet 3 inches, the weight distributed over the axles is 10.25 tons, or approximately 1.94 ton per foot run. It will thus be realized that with a crane of this type, the stresses upon the bridges over which it may pass are very considerably reduced. The crane is steam driven, the boiler of the Hopwood type being 6 feet 3 inches high by 4 feet diameter, while the cylinders are 9 inches bore by 11 inches stroke.

The apparatus has aroused considerable interest among European railroad engineers, and it is conceded that by this application of the articulated relieving girder to crane design, the difficulty of constructing heavy breakdown cranes without incurring any risk of overstraining existing bridges over which they may have to pass has been completely solved.

PANAMA A HALF-CENTURY AGO.

EXTRACTS FROM A FORTY-NINER'S DIARY.

BY MARCUS BENJAMIN.

A LITTLE more than fifty years ago the news of the wonderful discovery of gold in California reached the Eastern States, and at once there began the rush for that El Dorado that continued until the Pacific slope grew into civilization. At that time the territory west of the Mississippi was largely an undiscovered country. Only the reports of the Lewis and Clark expedition were available, and indeed, with the exception of Bonneville, Bidwell, and then Fremont, no one had crossed the United States to the ocean. Soon, however, the caravans of the argonauts of '49 began their tedious journeyings across the plains, mountains, and desert, and like the Spanish *conquistadores* of an earlier period, lured by their lust for gold, wandered through unknown lands, often to untimely death, marking the trail of their pathway with the bones of those who succumbed to the rigors of the journey.

In time came the exploration for a Pacific railway which established the most favorable routes across the continent, although it was not until after the civil war that a transcontinental railroad became a reality. Meanwhile those who sought fortunes in the West for the most part crossed either the Isthmus of Tehuantepec or the Isthmus of Panama, and of these two the latter became the favorite route.

Among those who went to San Francisco, not to make a fortune in mining, but in the regular channels of business, was my father (Edmund Burke Benjamin), from whose diary the following facts are taken of a trip across the Isthmus of Panama.

The diary is written with pencil in an old blank book and from it I have tried to glean such information as will make a connected story of the experience.

The first entry that is pertinent is on February 17, 1852, where I find the statement: "Have concluded to go to California." He then adds that he procured tickets to sail on the 13th of March next by the "Sierra Nevada" on this side and the "New Orleans" on the other. Further on he writes, "I am going via Panama and Chagres" from New York, and tells of the payment of \$300 "for first cabin fare and no berth at all," which he describes as "cheap."

For reasons that do not appear, the sailing was deferred until March 17, and then postponed for a day in consequence of the unusually unpleasant weather, but on the 18th he writes, "We finally got out at 12 o'clock, though it has been cloudy and rainy all the morning."

Nine days later, on March 27, the first part of his journey came to an end, and he writes:

"Saw Porto Bello at about 7, arrived at Chagres at 10 o'clock.

"After the anchor was dropped, numbers of natives came out in small boats to take the passengers ashore. The din of their Spanish jargon was very loud and disagreeable, each vying with the other to get near the ship and obtain passengers. After waiting until nearly all the passengers had left the vessel, I agreed with one of them to carry us to the shore for a dollar each. As the water was rough we had quite a tedious trip

across the bay. On reaching land I immediately secured our passage from Chagres to Gorgona with a colored man named Freeman for the price of eight dollars each, with the understanding that we were to find ourselves. This was at two o'clock. After waiting for a pass until four o'clock under a broiling sun, we started in a flat-covered boat for Gorgona. Our boat was capable of holding about fifty persons. We carried some twenty-six passengers and their baggage. At ten o'clock we stopped at Gatun for the night.

"On the following morning we started at two o'clock with five oarsmen and a captain on board. At ten miles from Gatun we breakfasted. Up to this time the boat had been rowed with oars, but thenceforth it was pushed along with poles. At about ten o'clock we left the boat and walked three miles on the railroad from Miller's Station to Bohio Soldado, where we waited until about half-past one, taking a nap, etc. The railroad was similar in appearance to those in the States, having square sleepers and square rails made hollow so as to be strong.

"The boat we had left then came up and again taking it continued our journey until dark, when we reached a ranch where we stopped over night. Here we found sage trees, say from thirty to fifty feet up to the first branch.

"In the morning took a bath, commended myself to God, and after breakfast went on until about noon, when we reached Gorgona, being in the first flat-boat to arrive.

"The Chagres River is a still, clear stream lined on either bank with abundant foliage and trees of curious growth, including various species of palms, cocoa, plantain, and many flowering shrubs, flowers of every hue and of the most delicious perfume, as well as fruits, such as figs, palms, nuts, oranges, limes, mangoes, and melons, were abundant. Among birds we saw parrots, turkey-buzzards, turkeys, swallows, orioles, etc., and of animals there were monkeys, lizards, scorpions, alligators, tigers (jaguar), panthers (puma), etc. The captain of our boat told us of a very curious animal that he had seen there. It had a back like a bear and head like a hog, with claws and was of a brownish color (great anteater).

"We staid in Gorgona at the St. Louis Hotel that day and engaged mules at eight dollars apiece to carry us to Panama. A charge of five cents a pound was made for transporting our baggage.

"We started from Gorgona at seven in the morning and after riding on mule-back till noon, reached the half-way house where we stopped half an hour for refreshments. The road wound through groves and over steep hills and rocky passes and accompanying streams.

"About two o'clock I left the party when within eight or nine miles of Panama and rode ahead at full speed in order to secure lodgings. I reached Panama about four o'clock and engaged quarters at the Cocoa Grove Hotel at a rate of two dollars a day. When within five miles of Panama I reached a paved road made by the Spaniards many years ago. On the way

saw the natives grinding corn for tortillas with wooden pestles as I passed by their houses. The rest of the party reached Panama after six o'clock in the evening, tired enough.

"Panama is quite a city, being surrounded by a wall encompassed by a moat. The houses are built of stone and are whitewashed within and without, with walls from one and a half to two feet thick. Wooden casements which open as a door, balconies, and small glass windows on the upper part of each side are peculiar features of every dwelling. The roofs are covered with tile or burnt brick, which are so heavy as to cause the roofs to sag. Inside, the rooms are large, and in consequence of the thickness of the walls, are quite cool. The modern houses are built of wood. The Spaniards, however wealthy, do not maintain great style, some of the best-furnished houses being those of American residents. Few of the latter, however, do their own cooking, but eat at some one of the restaurants, or have their food sent in, at an expense of ten dollars a week for each person. The wealthier residents dress richly and costly. I noticed one who wore a necklace of precious stones and another had one that consisted of five-dollar gold pieces. These were of the better class who live near the ocean in order to get the cool sea air.

"The cathedrals are large structures of stone with walls of from one to one and a half feet in thickness. The towers are covered with sea shells and contain chimes of bells. I saw one chapel in which there was a fine painting of the Virgin Mary and also one representing our Saviour upon the cross. On either side was a basin of holy water and a lamp. Six candles, burning all the time, were in front of the Virgin. The visitors as they pass, enter and cross themselves with the holy water and say prayers and Ave Marias.

"In the center of the city is a Grand Plaza, and facing it is the Custom House, as well as the office of the United States consul and transportation and express office. In the suburbs the houses of the natives, as was the case at Chagres, Gatun, and other places that we passed through, consist of four simple upright posts of bamboo covered with a roof of thatched plantains and palm leaves. Some were two stories high and some had but one partition, while others consisted of only one room. The natives are friendly and obliging, particularly so if they get paid for it. They never fail to acknowledge a salutation.

"The weather is hot and I find that I get very tired and am glad to retire at nine o'clock. Our hotel is a pleasant Persian-like villa, and is the best in Panama. They have a variety of tropical fruits, coconuts, star apples, oranges, mangoes, and bananas. They have an ant-eater, two monkeys, a llama, two mackaws, and a native turkey-like bird but with a tufted head (curassow).

"On my way to get our baggage, I passed a market where I saw beef hanging up in the hot sun to sell, having been cut in long strips or strings off the ribs. Fruit in every variety is likewise exposed on the streets. I observed a large school composed of native

urchins, say from eight to ten years. The schoolmaster sat still and the scholars all recited in concert without a prompter. While waiting for the opening of the transportation office, I went into the Cathedral on the Grand Plaza. As I entered, I noticed the similarity in material to the older houses and stone pavements. In the back part is the choir, being an inclosure of bamboo gilded and having an elevated chair covered by a canopy, with seats extending on either side. The roof is supported by heavy stone pillars arched and whitewashed, and is composed of boards covered with tiles sustained by rafters, rough enough. In the front and grand center is a highly elevated arch, having niches sustaining figures of saints. These are richly colored, dressed, and gilded, as are also the moldings and carvings about the altar. Scattered here and there were movable confessionals, consisting of square paneled rooms of box or cypress wood having a roof and a gate for entrance. On either side for a footing space holes are cut in fanciful shape for the person who kneels during the service. The confessionals were about three to five feet square and eight feet high. The church contains no pews, but wooden benches with backs in the aisles. Near the altar were slabs indicating the resting places of the rich. The altar ornaments and candlesticks are of solid silver. I saw many persons devoutly praying in the aisles; the better class kneel on rugs, the poorer on the pavement. Soon a priest came in and administered the Holy Sacrament to most of the persons present. I noticed specially a group of Spanish señoritas kneeling near the altar who were almost as white as Yankees; they seemed very devout. A solitary singer occupied the choir. She chanted in quite a monotonous way, like the Chinese, while the priest joined in and alternated. During the service the carpenters were hammering in the back part of the building while devotees whispered and laughed even while crossing themselves. Comment is unnecessary! The cathedral is about one hundred feet long and equally broad and seventy feet high.

"I saw a sloth, which is a mole-like animal, large as a pig, and with hair like that of a bear.

APRIL 2.

"This is Good Friday and a day of note among Catholics. I visited the American and Spanish burying grounds; the former I found to be a quiet, shady spot resembling our own God's Acre at home, the latter is quadrangular in shape, inclosed by a stone wall eighteen inches thick and a grand arched entrance of highly ornamental masonry. It bears the appearance of great age.

"Within the cemetery are vaults in rows of three from top to bottom, one over the other, eight to ten feet deep, and say some fifty on each side with room for several hundred more. The ground is also filled with graves; some of them have a cross at the head. These are said to be the graves of those who are in purgatory. At each of the four corners is a vacant space of about ten feet square where they burn the bones of persons who have been buried. They allow them to remain in the ground for six years and then take them up, coffin and all, and burn them together. This leaves space for new tenants. There was quite a pile of bones in each space. From the inscriptions, the majority of those now in the vaults have been buried during the last two or three years.

"During the evening it was clear and moonlight, and it was my good fortune to witness one of those grand religious processions that are characteristic of a Catholic country.

"First came a priest followed by two rows of children bearing torches and guided by their parents. Next a priest bearing a banner of blue silk, and then I saw carried on a scaffolding a large wax figure of Christ on the Cross gaily decked with gold and flowers and having a silk waist cloth. On this support were perhaps one hundred lighted candles, protected from the wind by clear glass globes. It was sustained by two long parallel poles on either side borne on the shoulders of six negroes, having a guide. Next came a wax figure of St. John the Evangelist bearing a cup and a piece of what appeared to be lace, similarly carried. Third, there was a large figure of the Virgin Mary, elegantly adorned and attired with silk, lace, and jewels. She was crowned and was seated on a throne. Over her head was a large canopy and twelve lights about the canopy, perhaps one hundred and fifty in all on the platform. Directly following were a company of native soldiers dressed in white linen with caps. They marched to the sound of a fife and drum, the latter played about as a six-year-old boy would play it at home. Meanwhile the church bell was tolling all the time. I can hardly say *bell*, as the bells here sound as near like kettles as anything else I know of.

"I saw also an old church (Santo Domingo) in ruins at the west of the town. The first arch is very elaborately carved and a fine piece of work. It is quite large, and the interior a succession of arches from the door to the altar. It now stands unroofed and the walls are covered with moss and ivy. The old bell lies neglected in the northwest corner and rubbish

fills the interior. Truly 'tis a splendid ruin! I find many such roofless and moss-grown buildings.

"I walked out on the wall in the southwest part of the city. It is about fifty feet wide in front of the barracks and is mounted with ten brass and silver guns weighing about four thousand pounds each—at least such is the mark on them. It is a very pleasant promenade and cool, looking out upon the water.

"This part of the city appears to be the ruins of what was once an important place that was constructed by the slaves of the Spaniards about one hundred and fifty years ago. It was destroyed by Bolívar and was not rebuilt until the present improvements were made in consequence of the great travel California-ward. I am told that in the year 1848 (before the emigrants passed in such numbers) the Grand Plaza was overgrown with weeds and underbrush. It is now entirely free from grass or brush or anything but sand.

APRIL 3.

"The weather is very warm but clear. I saw to-day a man who is said to be a descendant from the Aztecs, a people that once inhabited all of Central America. The guns that I mentioned as having seen yesterday I am told were cast in Barcelona, Spain, in 1777; also that under the broad walk previously mentioned is the famous calaboose.

"There is a fine view of the bay and the city from our hotel which is specially attractive at night when the moon casts a sheen upon the waters and makes long shadows, showing the ruins and persons ashore.

APRIL 4.

"Palm Sunday. The steamship 'New Orleans' arrived early this morning, and will probably leave for San Francisco toward the end of the week. I attended service at the Western Hotel. It was conducted under the auspices of Mr. Rowell, who was sent from New York by the Congregational Society.

"Another interesting religious procession occurred to-day. There was carried through the streets, on the back of the foal of an ass, an image of our Saviour. The people carried palms in their hands and bared their heads as the procession approached. We also are obliged to remove our hats when these Catholic ceremonials occur.

APRIL 5.

"The weather continues warm and clear. I have felt more comfortable to-day than at any other time since my arrival, probably because I am becoming somewhat acclimated.

"The United States, I am told, offered seventy-five thousand dollars for the guns on the battery, but that offer was declined.

"I learned that about fifty miles above here on the coast is a lake where the natives are said to gather pearls, rubies, emeralds, and other precious stones. I have this from good authority.

"The Island of Tobago and town can be easily seen from here. The latter in clear weather only.

"The 'United States' arrived to-day from New York, having made the trip in seven days and eighteen hours.

APRIL 6.

"The weather is clear and pleasant. It seems to me that the birds sing only in the morning and then they are followed by locusts who fill the air with the sounds of their buzzing.

"There is so much that is new and novel about me that I find no room in which to chronicle my own thoughts and ideas. Still my mind frequently wanders to the dear ones in my native land. It seems to me that the changes are greater there than in this hot, tropical clime where the same scenes are continually repeated. Enlightenment and the influence of Christianity would work a world of wonders here. If this isthmus could be settled and the ground tilled, much of the unhealthfulness would disappear. Many of the diseases that prevail are caused by decaying vegetation which has long been allowed to remain undisturbed but which would render the soil very productive if only ploughed under. When the rain falls a miasma rises from the ground, causing fever. Unsanitary conditions prevail that are very objectionable. There are no sewers and the offal is allowed to remain on the ground until carried off by turkey buzzards.

"The 'Cherokee' arrived to-day from New York by way of Havana, and made the voyage in thirteen days.

APRIL 7.

"There was a thunder storm to-day and it rained for a short time. I sent a long letter home by Adams Express at an expense of sixty cents. Mr. Ralston, of this place, kindly gave me a letter of introduction to Mr. Harris, the purser of the 'New Orleans.' This boat is said to be both seaworthy and convenient, and I am delighted that we are to go on her to San Francisco. I find myself more predisposed to cough than to fever in this climate.

APRIL 8.

"The 'New Orleans' is advertised to sail to-morrow. One of the waiters at our hotel died this morning from the fever and a complication of disorders. Poor fellow! when we came, only nine days ago, he was the

smartest and the healthiest looking of all the waiters here. Truly, life is but a shadow!

APRIL 9.

"Arose early. From ten to twelve o'clock I was occupied in getting on board the steamship 'New Orleans' bound from Panama to San Francisco, a distance of 3,250 miles. We went from the wharf in small boats on which we paid one dollar as our fare from shore to ship. It cost ninety cents each to carry our trunks from the hotel to the wharf. The natives were very unwilling to work on Good Friday, so it was only with the utmost difficulty that it was possible to get baggage carried at all, and we were most fortunate in obtaining an express wagon. Oh! what pushing, driving, and hauling! I came near having my limbs broken and my neck too. I presented my letter of introduction to the purser and found him a very pleasant young man from one of the Southern States.

"It was not until five o'clock in the afternoon that we were able to get our dinner, and finally after great ado, we started for San Francisco at six o'clock. I retired at eight o'clock to berth No. 63 in Room 21, upper cabin, and soon went to sleep."

San Francisco was reached on April 30, and the "New Orleans" was made fast to Long Wharf at the foot of Commercial Street at half past five o'clock in the morning. At last he had reached El Dorado.

Of the voyage itself no special comment is needed, although it may be mentioned that the following sad fact I find recorded on April 26: "Another of the passengers has died on board of ship since leaving Panama." His itinerary may be summarized as follows:

New York to Chagres.....	9 days.
Crossing the Isthmus.....	3 days.
At Panama.....	10 days.
Panama to San Francisco.....	21 days.

A little over half a century ago it took forty-three days to go from New York to San Francisco. To-day the same result may be accomplished in less than five days. The development of our transcontinental railroads has indeed wrought wonders.

NOTTINGHAM LACE MAKING.

THE total annual value of Nottingham's lace output is about \$25,000,000. The United States is the largest individual buyer, taking a quarter of the total, and every other country in the world takes some share of this British product. Concerning its manufacture Consul F. W. Mahen writes:

Nottingham is pre-eminent in the production of machine lace, for several reasons—among others the invention of the stocking frame in this county; the inventors and improvers of lace machinery were Nottingham men; the damp climate. Cotton-cloth making was first started in Nottingham, but was moved to Lancashire because the climate was not damp enough here, though right for lace making.

The machines now in use in the Nottingham lace industry are the Levers, lace curtain, plain net (all based on Heathcoat's invention, with Levers' improvements), and warp lace (an adaptation of the knitting machine). A German machine for making embroidered net and lace is used to a limited extent, and also the Barmen machine, of mixed German and French origin, producing a clever imitation of hand-made lace. The product of the machine, being in a crude brown state, must be bleached and otherwise treated to render it fit for the consumer. These various processes closely followed in development the making of lace. Samuel Hall, of Nottingham, patented certain devices during several years, beginning with 1817, which are essentially those used to-day.

The number of people directly dependent on the lace industry is estimated at 50,000, and the number indirectly dependent thereon is probably 125,000—half the town's population. At least 600 firms are engaged in making, finishing, or marketing lace. A few combine the three, most of them both finish and sell, while a comparative few deal in the finished article only. The number of firms weaving lace is 135. The annual output of the largest factory is worth about \$1,000,000, and of an average factory about \$250,000. Wages of factory hands range from \$4 to \$20 a week, depending on the skill or knowledge required. Their mode of living is much like that of other working people, though they dress rather more smartly, owing perhaps to the influence of their artistic trade.

Particulars of the coal consumption of the turbine steamer "Virginian," running between Liverpool and Montreal, have recently been published. In a series of voyages the boat has averaged 17.2 to 17.65 knots at an estimated power of 12,700 indicated horse-power. The average coal consumption for the propelling machinery only was 1.30 pounds per indicated horse-power. Including the auxiliary machinery it was 1.42 pounds, and including electric light also, 1.507 pounds.

HYDRAULIC RIVETING IN THE "MAURETANIA."

HOW FOUR MILLION RIVETS WERE DRIVEN IN THE BIG STEAMSHIP.

BY E. W. DE RUSETT.

As one of the most important factors in the construction of a steam vessel is the riveting—and especially so in vessels of such dimensions and power as the "Mauretania" and her sister vessel, "Lusitania"—it was determined to resort to hydraulic riveting to a much larger extent than usual, primarily on account of the thickness of the plates, 22/20 inch, and the length and large size of the rivets. This decision was come to after duly considering the effect of hydraulic riveting on the progress of the work, and it was considered advisable to extend it to the following parts of the structure, viz., the keel plates, center keelson, garboard strake, and shell plates within the range of the double bottom, also the connection of shell to stem and stern castings, floors, frame bottoms and top bars, tank girders, web frames, reverse bars to frames and tank side knees, and also the girders forming the engine seating.

The topside plating and doublings are also hydraulically riveted for a length of about 520 feet amidships, and the shelter deck stringer and doublings for a length of about 440 feet, as shown in Fig. 1.

The seams of the bottom shell plating of the vessel, where hydraulic riveting was resorted to, are arranged clincher fashion, so that the machines could close the work stroke by stroke. The frame bottoms are jogged. The bottom shell butts are double strapped, the inner strap having three rows of rivets, two of which are close pitched, the outer row being wider spaced. The outer strap is double riveted, with edges beveled to reduce resistance. The keel is formed of three plates, the middle piece being 1/20 inch thicker than the garboards, to allow of their being placed in position after the keel plates and longitudinal keelson bars were riveted. The butts of the keel plate are not strapped, as it was found there would be sufficient margin of strength without doing this. By the omission of these straps about 1/4 inch of draft was saved. This was of great importance, considering the small margin of dead weight that it is possible to obtain in a vessel of this character on the given maximum draft of water.

The plating of the topside, where the doublings occurred, had to be so arranged that the inner edge of the landing was kept at the top, so that each plate could be riveted up in due order (Figs. 3 and 4).

THE HYDRAULIC RIVETING MACHINES.

The eight hydraulic riveting machines employed were of three sizes, having gaps 5 feet, 5 feet 6 inches, and 6 feet, respectively. The 5 feet 6 inches gap machines were found to be the most serviceable for general purposes. They were each fitted with an adjustable arrangement by which the pressure could be brought to bear directly through the axis of the rivet at whatever angle the plating lay, the result being that very little trouble was experienced in pressing the rivets fairly into the countersink. The machines were supported by trolleys running in the roof of the shed under which the vessel was built, also from derricks which were guyed from the standards of the shed, as shown in Fig. 2, the trolleys and derricks being so arranged that they could be readily moved to any required position within their range of action. The shell rivets called for very careful consideration, both as regards the convexity of the head and taper of the neck and their length in proportion to the thickness of the plates they connected.

The proper relation of the bevel of the countersink to that of the neck of the rivet was a matter of much importance, otherwise a sound watertight job could not be readily obtained. And, further, to insure good work, any burr left on the edge of the countersunk rivet head during manufacture was ground off. Fig. 5 shows the bevel of the countersink in the shell for neck and point of rivet, also the bevel of the neck of the rivet before being closed up. It is worthy of remark that it was found by experience that the bevel of the rivet neck had to be less than that in the plate to insure good closing, otherwise the material did not solidly fill the hole from the root. The angles of these bevels are, for the neck of the rivet 18 1/2 deg., and for the plate 20 deg., each measured from the axis of the rivet. The proper length of the shell rivets was a matter of experiment, as the rule for hand-laid rivets did not apply on account of the great pressure employed in closing them, which amounted to about 50 tons.

By reference to Figs. A, B, C (Fig. 5), it will be observed that the heads of the rivets in the keel were made fuller than those in the garboards and three adjoining strakes, while further up the bilge the heads were finished with only the usual amount of fullness to afford as little resistance to the water as possible.

The countersunk rivets in the bottom shown at A and B, were put in from the under side and clenched on the inside, and those on the top side C were also clenched on the inside, the heads being rounded, as shown in the diagram. The deck rivets were countersunk and flush on the top on account of the deck sheathing, and clenched on the under side.

FOUR MILLION RIVETS.

Mild ingot steel was employed for all the rivets at the strong recommendation of the authorities of Lloyd's Register from their experience up to date.

read before the Institution of Naval Architects at Bordeaux, June 27, 1907.

THE MICROMETER MICROSCOPE.

In automatically graduating a circle it has been found to be impracticable to cut more than six lines in a minute, and it requires about thirty-three hours to divide a circle into two-minute spaces. As with the running of the finest clocks, so only can the best results be obtained when the machine is surrounded with every favorable condition possible. Instead of the



FIG. 1. PROFILE SHOWING EXTENT OF HIGH TENSILE STEEL AND HYDRAULIC RIVETING OF TOP SIDES.

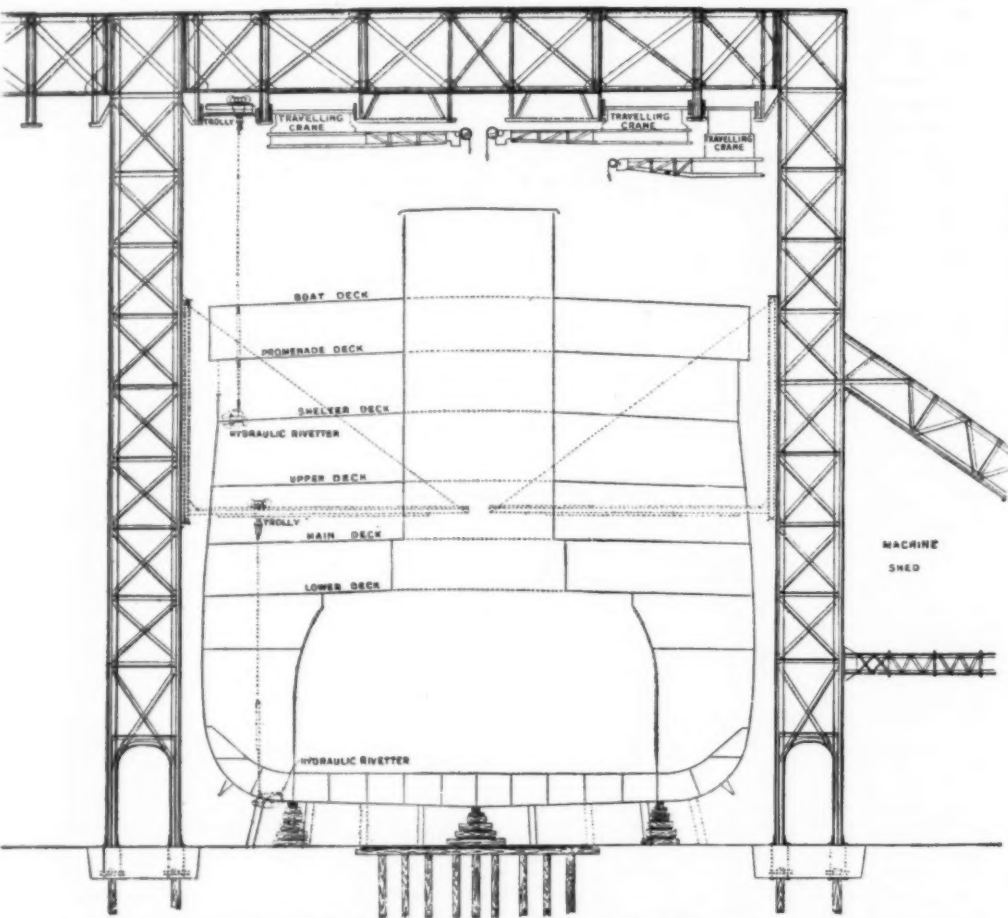


FIG. 2. Q.T.S.S. "MAURETANIA" IN SHIPBUILDING SHED, SHOWING ARRANGEMENTS FOR SUSPENDING AND TRANSPORTING BY HYDRAULIC RIVETERS.

HYDRAULIC RIVETING IN THE CONSTRUCTION OF THE "MAURETANIA."

The rivet rods were therefore specified to have a tensile strength of from 26 to 30 tons, with an elongation of not less than 20 per cent, and an elastic limit of from 13 to 15 tons. The rivets are of 1 1/4 inches diameter, and are spaced to give an area at least equal to the requirements of Lloyd's rules for mild steel plates of equivalent strength to the high tensile steel used. Under ordinary conditions of riveting by hand this area might be questioned on account of mild steel rivets being employed for the connection of hard steel plates, but it was considered that the hardening effect produced on the rivet by an hydraulic pressure of 50 tons overcame this objection, and also through the increased efficiency of riveting, and the fact that the sharp edges of the holes in the plates were removed, as shown in Fig. 5, by a special tool.

Upward of four million rivets were used, weighing fully 700 tons, a considerable proportion of which are hydraulically riveted. They were heated in oil furnaces, specially designed at the Wallsend yard. Each furnace has a daily heating capacity of at least 3,000 rivets, 3/4 inch by 3 inches.—Abstracted from a paper

large circles and sectors used by the ancients, circles of smaller diameter have been made as the methods for graduating have been improved, until those of the more modern instruments are seldom greater than 30 inches, and some of the latest meridian instruments have circles of but 25 inches. The smaller circles, which can be made and graduated with greater precision than the larger ones, are also less liable to change in form, owing to their weight and the variation in temperature, and with the aid of the reading microscope the results obtained would not be possible with the larger circles. A 25-inch circle read with a microscope having a power of 40 would be equivalent to a circle of about 80 feet in diameter, and a single second of arc, as seen through the microscope, would be equal to 0.0024 of an inch, a quantity easily subdivided. A most important adjunct to the astronomer's instrumental equipment is the filar micrometer. With it he determines the errors of divisions, the eccentricity of his circle, and measures the angles to within a fraction of a second; and when used at the eye end of the telescope he determines the positions and mo-

tions of the stars and the distances and diameters of the planets. In these little instruments, whether of the simple or complex form, the chief requisites are the screw and the cross wires, for upon them the value of the observations and measurements depend. To

make the screw of a micrometer so true that the errors in the threads cannot be detected by its own magnifying power is an extremely difficult task. These micrometer screws are often made with 100 threads to the inch, and are provided with graduated drums having

100 divisions, the readings being made in tenths of a division. The cross wires, which are but common spider lines, because of their fineness and the remarkable qualities they possess, are indispensable in micrometric work.

SCIENTIFIC WATERPROOFING.*

NEW LIGHT ON AN OLD SUBJECT.

THE problem of how to protect structures from dampness is one whose solution was attempted in the remote ages of antiquity. Since the world was in its youth, there has been an unceasing struggle against the invasion of water into places designed for human habitation.

It remained, however, for recent years to witness the

(1) In the foundations of buildings extending below the ground-water level, to keep the basements free from ground-water.

(2) In building foundations not below ground level to prevent the absorption of ground-water and ground-air by the foundation walls, causing dampness in the building.

owing to their great affinity for water, should particularly be subjected to a waterproofing process.

(8) In tunnels intended for public travel, water and dampness must be completely excluded. This becomes more difficult as the hydrostatic pressure is increased.

(9) In structures intended to retain water such as reservoirs, standpipes, swimming pools, etc., the lining must be water-tight, or the structure will not fulfill its mission properly. Percolation into reservoirs and conduits from sewers or contaminated water sources must also be guarded against.

(10) While the protection of structural metal from corrosion is, perhaps, a separate branch of the problem, the essential qualities of protective material for this purpose are quite the same as for those intended for masonry.

There are, unquestionably, other conditions under which waterproofing can be made a substantial aid in structural completeness, but these are sufficient to indicate the broad field open to the engineer and manufacturer.

Essential properties of the ideal waterproofing material are:

(1) The material should have no affinity for water. It should be a water shedder or "contra hydra."

(2) It should have a strong affinity for the material to which it is applied.

(3) It should be non-porous and impermeable under all pressures.

(4) It should be strong enough to bear pressure without breaking or cracking.

(5) The bond between it and the protected material must be strong enough to resist any separating influences.

(6) No water or gases should be able to find their way between the waterproofing and the masonry.

(7) It should be elastic, so that it may expand and contract without suffering injury.

(8) It should expand and contract at the same rate as the masonry, so as not to separate therefrom.

(9) It should have a high melting and a low freezing point, so that it may be unaffected by extreme changes in temperature.

(10) It should be a poor conductor of heat.

(11) It should withstand settlement, shock, jar, or vibration, and these should have no power to separate it from the masonry.

(12) It should not be abraded by atmospheric dust, wind or water when used upon exposed surfaces.

(13) It must be proof against chemical action due to atmospheric or to underground conditions.

(14) It must be insoluble.

(15) It must not decompose or disintegrate.

(16) It must have no injurious effect on the strength or bonding quality of the stone or masonry to which it is applied.

(17) It must not interfere with the setting of the mortar.

(18) It should be uninjured by standing water, escaping gases, etc.

(19) It should not discolor the surface to which it is applied when this is undesirable.

(20) It should be cheap, easy to apply, and operative with unskilled labor.

A perfect material possessing all the essential qualities above mentioned cannot probably be found, but that which comes nearest to the ideal in the most important requirements should prove the best and most economical one to use under the particular conditions present in any given case.

There are a number of practical points which if kept in mind when conducting waterproofing work would avert many costly mistakes. Among the more important ones may be mentioned the following:

(1) The structure should be designed so that it may properly receive waterproofing.

(2) A head of water which has developed or is likely to develop, should be provided for by a well-arranged drainage system.

(3) Only such materials should be used as are suited to the actual conditions. The success resulting from certain methods and materials used elsewhere is not always to be considered a criterion. Each individual case demands its special application, as to materials and methods.

(4) The surfaces to be treated should first be freed from voids or irregularities that might interfere with the efficiency of the work.

(5) Sufficient working room should be provided for

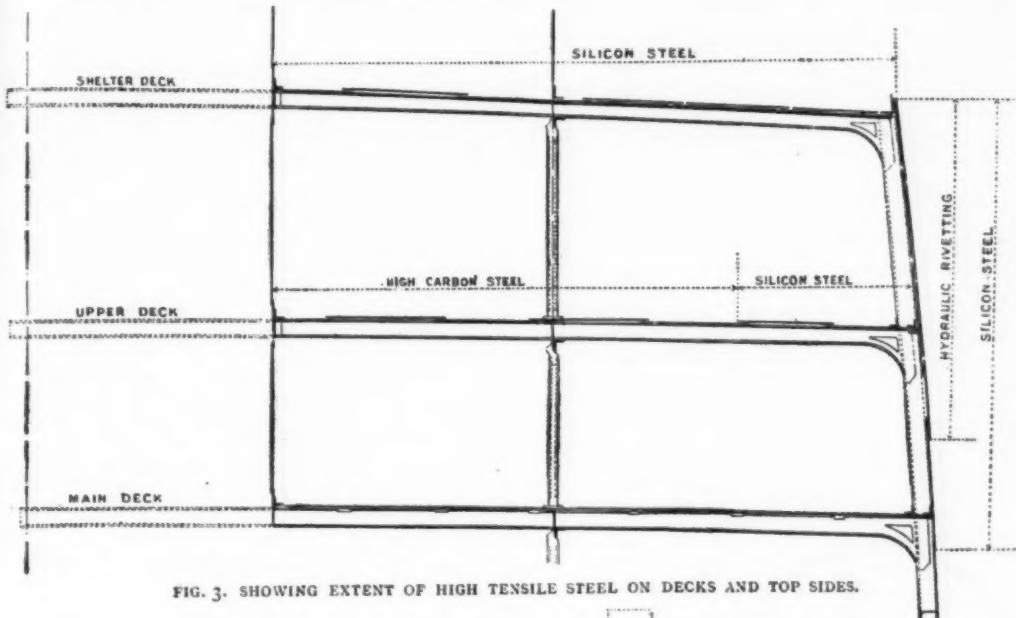


FIG. 3. SHOWING EXTENT OF HIGH TENSILE STEEL ON DECKS AND TOP SIDES.

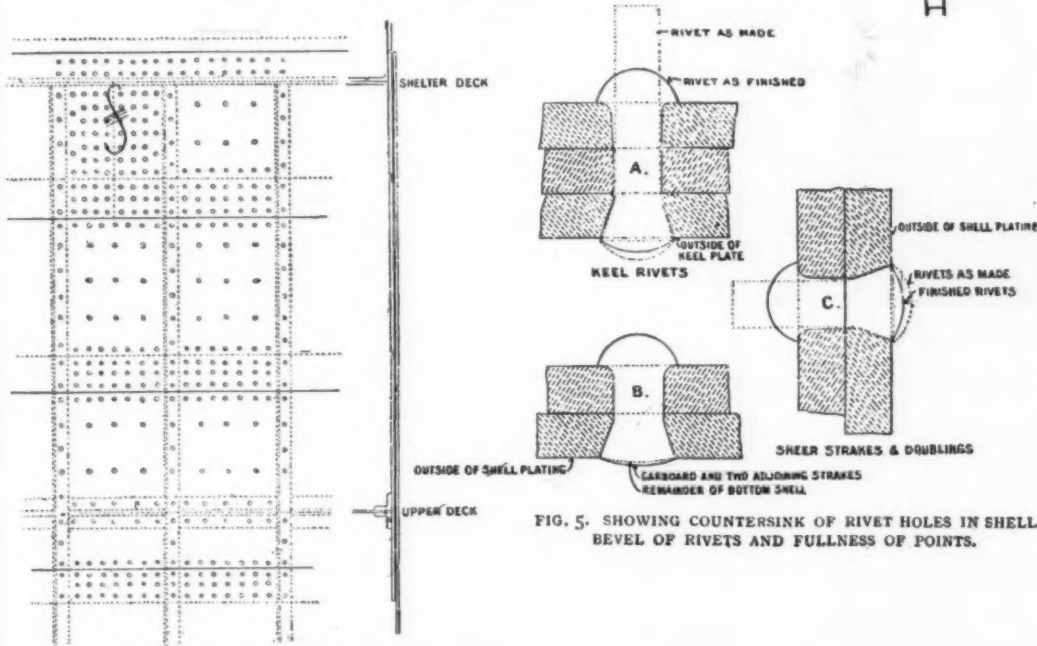


FIG. 4. SHOWING ARRANGEMENT OF SEAMS OF TOPSIDE PLATING TO SUIT HYDRAULIC RIVETING AND CONNECTIONS OF PLATING AND DOUBLINGS.

HYDRAULIC RIVETING IN THE CONSTRUCTION OF THE "MAURETANIA."

development of structural waterproofing from a mere makeshift to its proper place and station as a leading industry, controlled to a large extent by scientific principles, governed largely by scientific laws.

Among the many advantages to be obtained from waterproofing structures may be mentioned: (1.) An increase in the safety, life, and healthy appearance of the building or structure. (2.) The prevention of dampness, conducing to more wholesome conditions and greater comfort to the occupants. (3.) The prevention of disfigurement to the exterior walls and interior decorations due to staining and efflorescence or other injurious action of water. (4.) The dispensing with air spaces in buildings and with the necessity for furring and lathing, thus making possible, in many cases, a decrease in the actual cost. The elimination of air spaces in the walls removes what is a prolific breeding place for insects, creating an offensive condition, difficult to combat in even the best-kept houses.

Waterproofing may be advantageously employed:

(3) On exterior walls of buildings to afford some protection from the elements against defacement by efflorescence and against dampness.

(4) On interior walls when used in conjunction with the exterior coat to dispense with furring and lathing, or in conjunction with the latter. Plaster may be applied directly to the inner waterproof coat, if the work is properly done and proper materials are used.

(5) For buildings of a public character, and others which are designed to endure, the stone used, especially if not weatherproof in character or if susceptible to decaying influences, may be subjected to a protective process, and the mortar may likewise be treated, provided, however, that the strength and binding quality of the stone and mortar and the setting of the latter are not interfered with.

(6) On structures which already show signs of decay, this decay may be partially arrested by a suitable waterproof application.

(7) Concrete blocks and structures built of concrete,

* Abstracted from Waterproofing.

the proper execution of the job. Cramping and crowding for space is not conducive to the execution of satisfactory work by a workman who is wielding a long brush.

(6) The waterproofing should be protected during and after the application. It frequently happens that waterproofing films are punctured through carelessness on the part of workmen or others.

(7) The work should be continuous throughout and contain no weak spots. Water is an unfailing discoverer of such places.

(8) The work should not be done in extremely cold weather. The limit may be considered as 20 deg. F. Better results can be obtained by waterproofing when the weather is warm. The materials used in waterproofing are, necessarily, sensitive to chilly temperatures, and the properties which make for efficiency in this particular work are more or less affected by freezing weather. For instance, the application of hot bitumen-cement to an ice-cold wall will produce a sudden chill, and this goes far to destroy the cohesiveness of the felt layers.

(9) Careful and conscientious, if not skilled, labor should be employed in waterproofing. Above all, the work should be always subjected to rigid inspection by a competent engineer.

(10) In general, each waterproofing problem presents features peculiar to itself, depending on locality, service, climate, and surroundings. Each problem must be studied and developed by itself, to secure the best and most enduring results. The supervision must be thorough, so that the designer's intention will not be thwarted by careless execution.

ELEMENTS OF ELECTRICAL ENGINEERING.—VII. PRINCIPLES OF DIRECT-CURRENT MOTORS.

BY A. E. WATSON, E.E., PH.D., ASSISTANT PROFESSOR OF PHYSICS IN BROWN UNIVERSITY.

Continued from Supplement No. 1666, page 358.

To make the energy of the electric current do mechanical work was a goal sought by the earliest experimenters. The discovery of electro-magnetism had apparently given the essential means of making an electric motor. A mass of inert iron could, by the mere closing of a circuit, be made to exert an almost instantaneous and vigorous pull upon a neighboring mass; then, by the breaking of that circuit, the magnetism would as suddenly and mysteriously disappear. This attraction and relaxation, that had been quickly adopted for telegraph receivers and electric bells, was soon applied to produce rotary instead of vibratory movement. As long ago as 1838, Jacobi, in St. Petersburg, made an assemblage of electro-magnets that actually did rotate, and with it he tried to propel a boat on the River Neva. Current was taken from a large number of Grove batteries, consisting of zinc and platinum for electrodes and sulphuric and nitric acids for electrolytes; the narrative states that people who came to see the rival of the steamboat were driven away

from the river banks by the noxious fumes of the acids. The propulsion of boats by electricity is a problem not yet satisfactorily solved; but it is now a matter of batteries, not motors—with Jacobi it was both.

from the river banks by the noxious fumes of the acids. The propulsion of boats by electricity is a problem not yet satisfactorily solved; but it is now a matter of batteries, not motors—with Jacobi it was both.

In general, the principle in this motor, as well as in many others of that time, was to arrange a number of U-shaped electro-magnets in a circle, held on stationary supports, then to have similar magnets, or merely iron bars, called armatures, mounted on a revolvable member. All the coils were in series, the circuit to the movable part being provided by sliding or rolling contacts. When the armatures were in front of the magnets, the circuit would just have been broken; when half-way between two adjacent magnets the circuit would be closed, and movement would take place in the direction of previously imparted momentum; when again in the nearest position, the circuit would again be broken, and momentum again relied upon to carry the masses to the next effective position. Such a motor is not necessarily self-starting, is intermittent in its "torque," or moving power, and the separation between armatures and poles is, much of the time, too great to allow an effective pull.

In another historic construction, the sucking action of solenoids was made the actuating principle. A crude model was made by Page, an American, and its importance so overestimated at the time, that speculations were at once made as to the possibility of operating railways by electricity. Bourbouze redesigned and embellished the machine, until it looked as shown in Fig. 28. In it is readily seen the spirit of the times as embodied in the development of the walking-beam type of steam engine. The analogy is very striking. For the vertical cylinders there are the double solenoids; for the pistons the freely-sliding solid iron cores; connecting rods and walking beam are used without modification; the alternate shifting of the current from one set of windings to the other is per-

formed by a sort of slide-valve commutator operated by an eccentric on the main shaft. As regards actual power, however, this electro-magnetic engine, as it was called, fell short of even the mark attained by the others.

Electric motors need consist of but a single moving part, and instead of letting them copy the design of reciprocating steam engines, it is more appropriate—as has actually been realized in the steam turbine—for the steam engine to copy the ideals of the modern motor.

It was certain that these early motors had serious defects—some of them obvious, others of a perplexing and almost exasperating nature. The jerky action; the burning and rapid deterioration of the make-and-break contacts; the exceedingly short range of effective attraction; heating of the iron and coils. These original motors were usually mere toys, and did little more than run themselves. Attempts to make larger ones were conspicuous failures, for the defects were all the

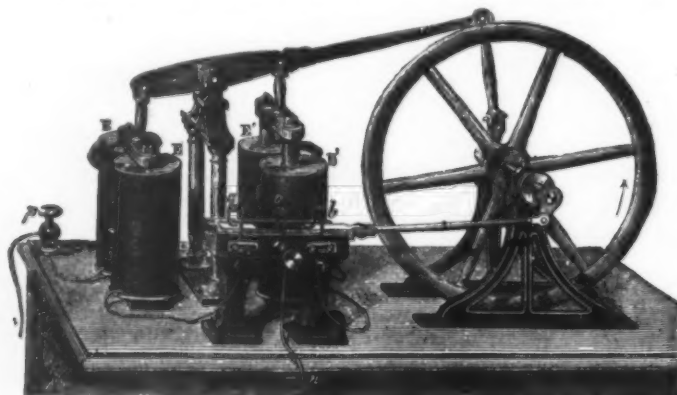


Fig. 28.—Bourbouze Electro-Magnetic Engine.

more prominent. It is strange that the real principles at stake so long eluded the patient experimenter and mathematician. Even as late as 1878, Count du Moncel, director of the French telegraph system, and writer of an extended treatise on electricity, after commenting upon the failure to produce commercially successful motors, states: "All these obstacles which interfere with the action of electro-motors of large size do not exist for small ones, for the elements of electro-magnetic action remain nearly the same; now what might be a great result for a small motor would be a very feeble one for a large motor; this lack of rigidity which destroys the benefits of the effects at a small distance is not felt for feeble forces and short lever arms; finally the spark of a feeble current in no way injures the metallic communications. This is why the electro-motors of a small model have always succeeded, while large ones have always deceived the hopes of their inventors. The conclusion of all this is that one should for a long time, if not forever, be on guard against the pompous announcements of certain constructors and of certain periodicals, who affirm that electromotors can be established having the force of several horses. What is certain is that up to the present time no motor has equaled one horse-power, and those who treat the problem as solved recall to us the fable of the hunter who sold the bear's skin before he had killed the bear."

Hardly had these sinister words been printed, before their conclusions were found to be in error. Enthusiastic and overdrawn statements from the early experimenters had so often deceived the public, that Du Moncel's warning was given in good faith; but the "pompous announcements," to which he referred were really the harbingers of the better day. The secret of proper motor construction and operation had just been found. In the rapid rise of electric lighting systems that took place during the next three years, the applications of electric power were not overlooked, and

at the Paris Electrical Exhibition of 1881 motors of presentable commercial sizes were displayed. It is stated that Du Moncel himself was a daily visitor, viewing with interest the motors of whose possibility he had only a short time before been so incredulous.

About this time Sir William Preece, in an address before the British Association, had stated that if an Alexander Selkirk had just returned to civilization, and had asked what had been the most important discovery made in his absence, the correct answer would be, "The reversibility of the Gramme ring." When it is realized that in those same years the telephone and incandescent lamp had both been brought forth, the importance of the scientist's opinion can be appreciated. By the Gramme ring Preece meant to typify the modern dynamo, with its laminated armature core, its sub-divided winding, and many commutator segments; by reversibility, he meant that the identical construction appropriate to the machine to allow it to generate the electric current by the expenditure of mechanical power, was the right one to permit the reproduction of mechanical power from the electric current. The Siemens drum armature would have filled the same conditions, only the discovery happened to have been made with Gramme machines. In other words, two such machines, as nearly alike as desired, could be connected by wires, either one driven by appropriate means, and the other would at once run as a highly satisfactory motor.

As in the case of most discoveries and inventions, there are contesting claims as to whom the credit belongs for finding out this valuable commercial qualification of dynamos. Earlier instances, before the demonstration with Gramme machines, seem to have been obscured through inherently poor constructions of apparatus, or with too small sizes, or to have failed of the public appreciation that was their due. At the present time no essential distinction is made in the building, as to whether a given machine is to be used as a generator or a motor; ordinarily a large structure might be suspected as intended for generating currents, while smaller ones, to which the current might be delivered, would operate as motors, and this distinction might be correct; but some very large motors have been made, and likewise very small generators, so the lapping over of mere size would readily eliminate any accurate classification based on that factor. Except for details in the method of winding or connecting the wires, purely for the requirements of starting and regulating, the electrical circuits of the generator and motor would be alike. Indeed, in regular dynamo operation, it is possible to make a given machine serve intermittently in the two capacities; sometimes, however, such a reversal of function occurs accidentally with ruinous results—a case to be explained in a later chapter on Central Station Operation.

In a modern direct-current motor there is, therefore, to be found a field magnet, consisting of one or more pairs of poles, an armature with a symmetrical ring or drum winding, commutator, and brushes, as explained in connection with generators in Chapter V. Power is required to drive a generator, for such a machine is merely a device to exchange mechanical for electrical energy. Experiment proves that work must always be done to push conductors conveying currents through a field of magnetic force. The real action is, of course, invisible, but the conventional representation by the use of lines of force gives a helpful graphic conception. If a current is flowing in a wire, lines of force will encircle it, and looking in the direction of the current, these lines will appear to revolve in the clockwise direction—a notation easily remembered by the "corkscrew rule"; if the current flows toward an observer the lines will circulate counter-clockwise. A convenient method of representing directions of currents in wires is to put a dot in the center of the wire to represent the point of an arrow for forward currents, and a cross in the circle for backward currents. With this conception, let a

wire conveying a forward current be placed between the poles of a magnet as given in Fig. 29. Lines of force are considered as emanating from a north pole and entering a south pole; these lines due to the field shown will, therefore, be directed from right to left. Lines of force, of whatever sort—whether of wind or water, material or immaterial—cannot cross each other, but new routes will be formed, by a merging of the different directions. By examining the diagram, it will be seen that the lines of force due to current and field will strengthen each other above the wire, and give curved paths, while below the wire the lines will somewhat neutralize each other. Lines of magnetic force always tend to shorten themselves, or as commonly said, magnets attract other bodies of iron; the lines have a tension, like extended rubber bands, and with such a force acting it is easy to see that the lines above the wire will tend to move it in the downward direction shown by the arrow. The force does not act to bring the wire nearer the magnet poles, to the right or the left, but to move the current equally away from the action of both poles.

An interesting confirmation of this principle can be found by bringing a permanent magnet near an electric arc; in this case, the path of the current from one carbon to the other is readily distorted, for a vigorous puff with the breath will readily extinguish the arc. The magnet will do the same thing, if held in a certain position near the arc, the current will be blown away; if reversed in position, the current will be sucked in between the poles. With a given direction of the lines of force and the current, the direction of the motion is invariable. Fleming has incorporated the phenomenon into a convenient rule, known as the "left-hand rule for motors": place the first finger in the direction of the lines of force of the field magnet, the second finger, at right angles to the first, in the direction of the current, and the thumb, at right angles to the other two, will give the direction of the motion of the conductor. To apply this rule to the diagram given in Fig. 29, it will be well to turn the page upside down, and lay the back of the left hand upon the table; the first finger will then point sidewise, the second directly up, and the thumb away from the person. With any two of the directions known, the third can readily be found. In order to remember which hand to use, a guide to the memory will be found in coupling the use of the right hand with the generator—both words have a "g" in them—the other hand belongs to the motor.

Another confirmation of existence of unequal forces acting on the two sides of the wire is given by the grouping of iron filings in the resultant magnetic field as shown in Fig. 30. The arrangement selected is such as to illustrate more closely the actual arrangement of a dynamo field magnet and armature core, the latter in itself being inert, but receiving magnetism by induction. A thin bar magnet with circular polar faces and a central iron ring was attached to a board, and a wire conveying current brought through a hole in the gap space; a sheet of paper was slipped over the wire, and laid on the magnet. The heaping up of the filings on one side of the wire and the completely barren spot on the other are unmistakable.

If a wire be bent in the form of a loop, or letter U, and one straight part placed under the influence of a north pole, the other under a south pole, both directions of the current will be effective, as can be proved by an application of the left-hand rule; a torque results, tending to rotate the conductor on an axis parallel to the straight portions and midway between them. In the actual assemblage of the wires and commutator on the armature of a dynamo, currents are flowing in a certain direction in all the conductors under one pole, in the opposite direction under the next, or other, pole. A uniform action, therefore, exists to produce a motion of rotation, for as fast as a given coil passes out from under the influence of a given pole, another coil enters the other edge of the same field. Comparing this principle with those found in the pioneer motors, the reason for their failure can be more readily understood. In the one, there is the almost perfect continuity of the current, the location of the conductors under polar faces of large area, with very short air gaps; the reversal of the current in one coil only at a time, and that one only a small fraction of the entire winding, and at a time when almost inert. In the other, the attempt suddenly to make and then to break the main circuit, the use of small magnet poles and long air gaps; the large number of turns of wire made the choking effects of self-induction a maximum, and the breaking of the circuit was so timed as to let the sparking be most disastrous to the contacts. Added to these sufficient defects was the use of solid iron cores in the magnets and armatures, with the consequent wasteful production of eddy currents.

The vital point to recognize and emphasize in the operation of an electric motor is the production of a counter-electromotive force due to the movement of the conductors in the field of force. By some inexorable law, whenever conductors cut lines of force, an electromotive force is produced. It makes no differ-

ence by what means the motion is produced, whether by the application of force from a steam engine or other prime mover, or by the motor action of the current itself. Referring again to Fig. 29, in which the direction of the movement is indicated, if, by any means, the conductor is thrust across the lines of force, the application of the right-hand rule will give the direction of the induced electromotive force. With the page held in the ordinary way, let the first finger point from the north pole to the south, the thumb toward the person, representing the direction of the movement of the wire, and the second finger, at right angles to these directions, will have to point directly

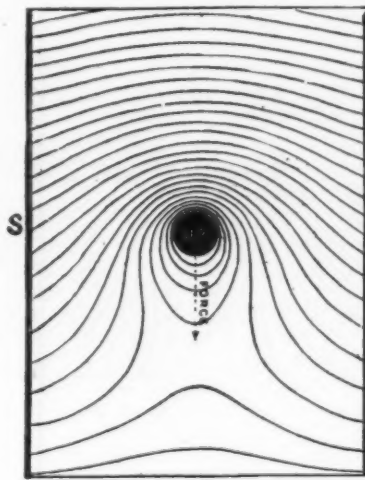


Fig. 29.—Lines of Force About a Wire in a Magnetic Field.

into the paper—in the direction just opposite to that in which the current is really flowing. That is, the direction of the electromotive force produced by the motion of the conductor is directly opposed to the current that produces that motion. There is also to be considered the production of a counter-electromotive force due to the self-induction of the windings of an armature; this is a factor which varies as the square of the number of turns in a given coil, and early motors having many coils in series of relatively fine wire possessed so much self-induction, as to make it impossible to force much of any current through them; therefore the resulting torque was so feeble as to produce slow rates of rotation, and to conceal the fact of a production of a useful counter-electromotive force.

Again, by the application of Newton's third law, that action and reaction are equal and in opposite directions, the necessity of this counter force must be realized, or there would be a serious infraction of the fundamental conception of motion. A person cannot push against a wall, without the wall pushing back; the yielding of the wall reduces the ability to push. Only in case the counter-electromotive of the motor pushes against the current, can the generator deliver any energy to it, for this force results from the mo-

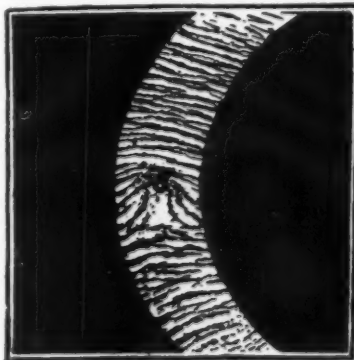


Fig. 30.—Lines of Force Due to Wire in Magnetic Field.

tion, and the counter force can be great only in case the proper speed is permitted. The real energy of any motive power can be expressed as the product of speed times torque (turning effort). In an electric motor, with a given strength of field magnetism, the torque is proportional to the strength of the current in the armature conductors, and the speed is proportional to the counter-electromotive force generated. Sometimes the attempt has been made to apply Ohm's law to the operation of an electric motor, but it is not appropriate without the admission of an important modification. As rightly applied in simple cases, there must be only one electromotive force at work; in the motor there are two—one supplied by the generator, and the counter one generated in the motor itself, and as far as overcoming ohmic resistances is concerned, the difference of these two opposing forces is to be taken.

This difference, in every case, divided by the armature resistance will give the true value of the current. The counter-electromotive force cannot be directly measured, however, but can be computed when the resistance of the armature and the strength of the current are known. For instance, a 1/2-kilowatt Edison shunt motor designed to run on a 125-volt circuit has an armature resistance of 3.3 ohms; at a particular instant it is loaded to such an extent that 4 amperes is passing through the armature. What is the value of the counter-electromotive force? From Ohm's law $C = E \div R$, whence $E = RC$. As far as the armature resistance is concerned then $E = 3.3 \times 4 = 13.2$ volts; that is, even if the armature was standing still, 13.2 volts would be required to drive 4 amperes through it, and even during rotation, this force will still be required, though it really represents a continual waste. If the armature be now allowed to rotate, a counter-electromotive force (often denoted as c.e.m.f.) will at once be generated, which will diminish the current. The only way to restore the value of 4 amperes will be to apply a higher e.m.f.; when just that value of the current is again attained, the applied e.m.f. must be just 13.2 volts higher than the c.e.m.f. If the applied value is 125, the latter will then be 111.8. Some particular speed of rotation is attained, the very one required to produce 111.8 volts as a generator. If the load on the motor is reduced, so that less current will produce the needed torque, the reduction in load at once allows the armature to turn a little faster, thereby generating a little higher c.e.m.f., the difference between this new value and the constantly applied 125 is just enough to drive the lesser current against the ohmic resistance of the armature. With the load entirely thrown off, a small current would be sufficient to produce the torque needed to overcome the various frictional and eddy current losses, almost no volts would be wasted, for the counter e.m.f. would almost equal the applied e.m.f.

In the design of a motor, it would be desirable to have the resistance of the armature winding really zero, but this is manifestly impossible; but such an armature would run at absolutely the same speed, whether the load was on or off. Efficient and well-regulating motors are made with very low resistance armatures, and it is quite a fallacy to regard the resistance of the winding as determining the proper voltage to be applied. It is true that a 500-volt motor of a certain size would have about four times the ohmic resistance of one of the same size adapted for 125-volt use, but in both cases the resistance should be as small as possible, and a modern high voltage armature could readily be found with a lower resistance than one made twenty years ago for 125 volts. The real factors determining the proper voltage to impress upon a motor are concerned with the strength of the field magnet, the speed and the number, but not the size of the armature conductors.

In the practical operation of an electric motor, there remains to be considered the method of energizing the field magnet; this represents an expenditure of energy, and of course affects the efficiency of the machine as a whole. A shunt-wound field means a continual draft of current—to be minimized by making the resistance of the windings as high as possible, yet allow the requisite number of ampere-turns; a small current flowing through many turns is the aim, with the limiting principle of having armature and field magnet losses about equal, but both small. A series motor must necessarily use large wire on the fields, permitting the number of volts lost therein to be about equal to that lost in the armature. Motors of 10 horsepower are ordinarily designed with an allowable loss of 3 per cent in the armature and 3 per cent in the field magnet. For a 500-volt winding, the armature should then have about 1 ohm resistance, the shunt field about 1,000 ohms, and allowing for frictional and "core" losses, the full-load current would be about 18 amperes.

Further consideration of the principles of electric motors and their control will occupy Chapter VIII.

Mr. K. Norden expresses the opinion in the *Elektrotechnische Zeitschrift* that for workshop illumination, mercury vapor lamps are likely to be largely used in the future, experience having shown that the light from such lamps is less fatiguing to the eye than that from any other illuminant. He regards the Aron mercury-vapor lamps as the most satisfactory, owing to the fact that they are provided with a self-lighting arrangement. These lamps have the form of vertical tubes, one size being 500 and the other 1,000 millimeters long. In order to facilitate illumination problems connected with the use of such lamps, the author establishes formulae for the horizontal illumination. In the simpler formula, the entire luminous flux is supposed to proceed from the middle point of the tube; in the more elaborate one, due account is taken of the linear distribution of the source. Comparison of the results obtained by the aid of the two formulae points to the advisability of using the more accurate one.

GERMAN ACCUMULATOR CARS.

A SOLUTION OF THE SUBURBAN TRAFFIC PROBLEM.

BY DR. ALFRED GRADENWITZ.

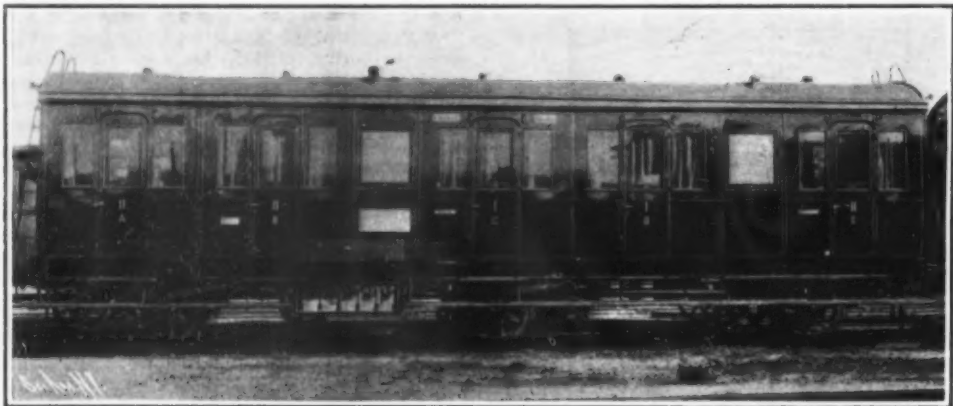
For certain branches of suburban railroad traffic the Prussian State Railroad Department has introduced an accumulator battery-propelled type of passenger car. The innovation was made in February last, and since then the cars have been in daily service upon

the world. This rather complicates the situation if one attempts to get alcohol from the cheapest present source, i. e., the refuse of cane sugar production. In the sugar-producing countries alcohol can undoubtedly be made at a figure which would permit its importation

of gasoline to put it in full competition merely on the basis of fuel cost. With gasoline at the prices now current in this country such competition in the gross, as it were, is for the present unlikely. But nevertheless the use of alcohol should be encouraged as an automatic check on increase of price in gasoline. As regards net value for the purposes of its use, alcohol has a much better situation, especially as regards its employment in automobile engines. The gain in its use is two-fold; first, it gives somewhat greater power in an engine of given size; and second, it burns far more cleanly. As regards the first count, one can therefore build a somewhat lighter and smaller engine for the same output. This is a distinct help, for one of the prevalent vices in automobile design is excessive weight for the motive power carried. A heavy engine means heavy supports. Incidentally the lessened danger of auto-ignition when using alcohol makes it easier to use air-cooled engines, which still further lightens and simplifies the structure. Further, the much cleaner combustion of alcohol lessens the danger of overheating and the chance of serious friction from the accumulation of soot in the cylinders. Gasoline is of complicated and variable composition and its tendency is to leave hard carbonaceous residues unless the combustion is exactly what it should be. And proper combustion in automobile operation is very difficult to maintain.

For these reasons there would seem to be a strong probability that the use of alcohol would tend to materially lessen repairs, an improvement which is very greatly to be desired. In spite of the fact that gasoline engines as now made can be used with alcohol, some minor changes in carbureters and compression, and perhaps in ignition, are desirable in an engine to be used exclusively with alcohol. It is to be hoped that some of the more enterprising automobile makers will take up the question and be prepared to furnish first-class alcohol engines if desired. The gain in the abolition of the unpleasant odor of gasoline is a material one, too, especially in cities where many malodorous machines are now in use.

As regards the use of alcohol in ordinary stationary engines the possible gain is less. Such engines can be run under fairly uniform conditions of combustion, and a little extra weight is of small moment. With the introduction of small gas producers, too, giving less fuel cost even than gasoline, there will be a tendency to confine the use of stationary gasoline engines to very modest sizes so that they will become relatively less important. Still if the production of cheap alcohol once gets fairly under way there is a good chance that the price can be brought to a figure that will encourage its use, especially since in some parts of the country the transportation charges on gasoline are considerable, while alcohol may be of local manufacture. At all events the automobile side of the matter may easily rise to considerable importance, and it is earnestly to be hoped that the work will be rapidly pushed along.—Engineering Record.



ONE OF THE NEW ACCUMULATOR-PROPELLED CARS IN USE IN GERMANY.

three of the district roads running from Mayence. These suburban railroads establish communication between Mayence and Oppenheim, Ingelheim, and Russelheim, and their lengths are respectively 12, 11, and 8 miles.

The general appearance of the cars may be gathered from the accompanying illustration. They are of comparatively light construction and each measures 40 feet in length. The body is mounted upon three single axles, being built or altered to this design for running with secondary batteries at the Tempelhof works. The cars are divided into six third-class compartments, each accommodating ten passengers, giving a total carrying capacity of sixty persons per vehicle. The axles are made of nickel steel provided with special steel springs, and the car, which when laden weighs 38 tons, has its weight distributed so that the middle axle carries the greatest proportion.

The battery equipment, which was supplied by the Accumulatoren-Fabrik Actiengesellschaft of Berlin, is of the Tudor type and comprises 180 cells, each weighing 121 pounds, and containing four positive and five negative electrodes. The capacity is 200 ampere-hours. Each cell measures about 13½ inches long by 5 inches wide and 18 inches deep. The batteries are disposed in groups of seven or eight according to the available space, and are stowed in boxes below the seats. The containers are sealed, there being a vent leading to a discharge pipe, by which the gases that may be generated escape into the air. The battery equipment represents a weight of approximately 10 tons and yields 68½ kilowatt-hours, and the output per watt-hour per pound is about the same as the energy obtained from stationary batteries. A single charge is sufficient to carry the coach a distance of 37½ miles at the maximum speed, and the batteries are charged at Mayence.

The maximum speed attainable is 28 miles per hour, but the average speed is only about 19½ miles per hour, and on the Mayence-Russelheim line about 21½ miles per hour. The cars make on the average from four to six runs per day. The general practice is to allow one car to make two round trips to Russelheim, a total distance of 32 miles, or one round trip to either Oppenheim or Ingelheim, a total distance of 24 and 22 miles, respectively; or to make a single trip on the shortest route and a round trip on one of the longer, so that the total mileage covered is as near as possible to the maximum capacity of the vehicle upon one charge, viz., 37½ miles.

The propelling mechanism comprises two motors, each developing 25 horse-power, fixed to the front and rear axles, and which can be coupled either in series or parallel, the drive being transmitted to the wheels through tooth gearing. There is an engineer's compartment at each end of the vehicle.

THE DENATURED ALCOHOL SITUATION.

In spite of the denatured alcohol law and the interest it excited, the results up to date have been inconsiderable so far as fuel uses are concerned. It is somewhat unfortunate that wood alcohol remains still the chief material used in the denaturing process, since when used in so large a proportion as 10 per cent, it is a considerable item of expense, while the pyridin bases employed if the amount of wood alcohol is reduced are not produced in material amount in this part of

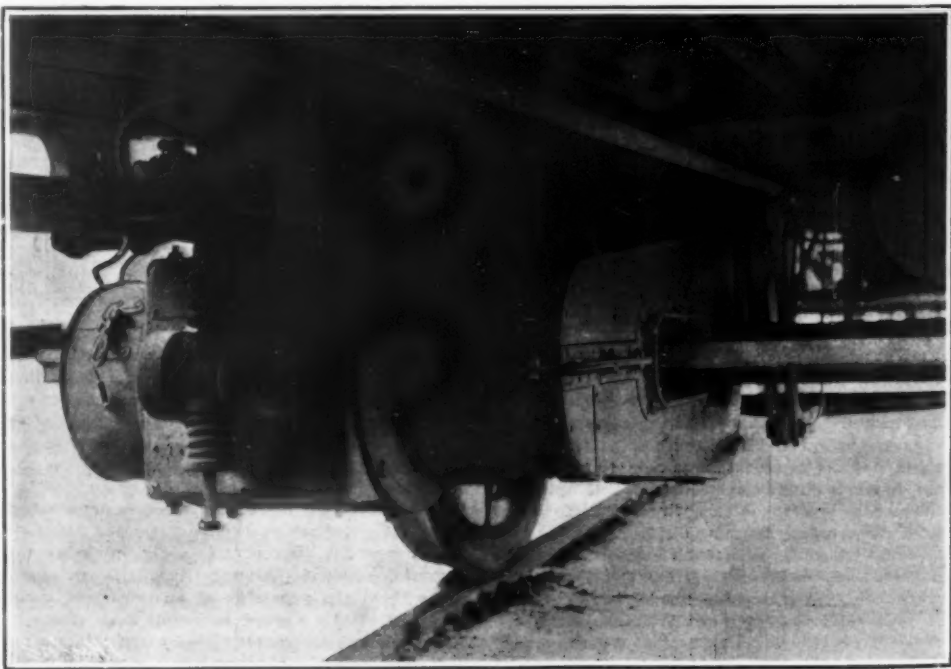
and denaturing at a price which would put it into immediate competition with gasoline. It is therefore much to be desired that a more convenient and cheaper process for denaturing should be authorized if one can be found.

As regards the results obtained with alcohol in gaso-



ONE OF THE COMPARTMENTS FOR CARRYING ACCUMULATORS.

line engines, they are upon the whole very encouraging. Of course there is no getting around the fact that gasoline has a higher thermal value than alcohol, gallon for gallon, in the ratio of nearly 3 to 2. Obviously alcohol must be obtainable at about two-thirds the price



THE PROPELLING MECHANISM. ONE OF THE MOTORS WHICH ARE ATTACHED TO THE FRONT AND REAR AXLES OF EACH CAR.

ACCUMULATOR-PROPELLED PASSENGER CARS ON THE GERMAN SUBURBAN RAILWAYS.

MANUFACTURE OF NITRIC ACID FROM AIR.

THE THOMAS AND BARRY PROCESS.

For centuries nitrogen has had a commercial value; and it has been derived from natural deposits, such as the Chilean nitrate beds. In recent years its use has enormously increased, for it enters largely into the composition of both explosives and fertilizers. There are signs that the natural nitrate beds will soon be exhausted, and as no substitute for nitrogen is available, some new source of supply must be tapped. The vital importance of nitrogen is indicated by its use in fertilizers. Modern farming works the ground beyond its natural capacity, and without nitrogen to replenish the soil, it would soon be impossible to raise sufficient quantities of wheat, and an acute food shortage would be faced. Fortunately there is a practically inexhaustible supply of nitrogen ready; and the raw material may be said to be "delivered at the factory"; for it constitutes four-fifths of the air we breathe, and it has only been necessary to find a practical way of drawing on the supply.

Experimenters have been at work on the problem

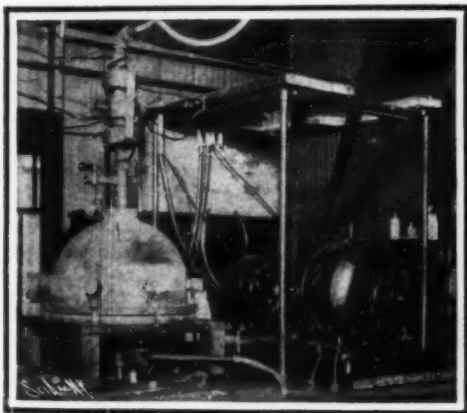


ELECTRIC FLAME USED FOR PRODUCING NITRIC ACID.

for some years, and about five years ago a factory was opened at Niagara Falls, only to be closed after running about three years. A second factory, started in Norway, was more fortunate and is still working.

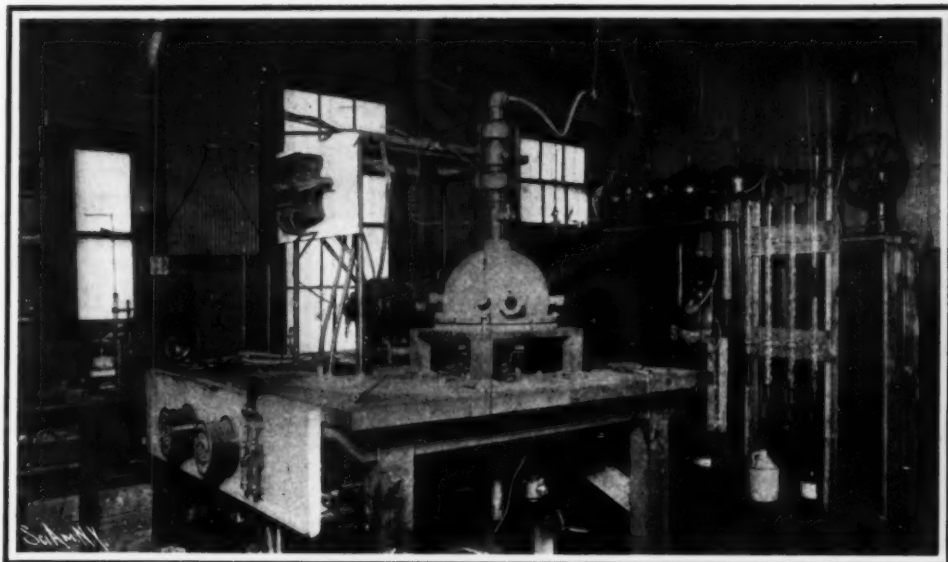
Nitric acid is naturally manufactured during a lightning discharge. Under these electrical conditions nitric oxide (NO) is formed by the combining of equal parts of nitrogen and oxygen. This nitric oxide combines with oxygen to form nitrogen peroxide (NO_2), which is soluble in water and combines with it to form nitric acid. In the manufacture of nitrogen compounds experiments have been made to substitute the high-tension electric discharge for the lightning flash. The idea was right, but it is only after several years of careful experimenting that the details have been so worked out as to place the manufacture of nitrogen compounds on a sound commercial basis.

The earlier experimenters wished to expose as much air as possible to the arc, and so drew the flame out to its extreme length and smallest cross-section, and fed it with a continuous blast of air. Later experiments have shown this to be wrong. A short length of arc gives nitrous oxide, and as the flame is drawn out more nitric oxide is produced, and when the arc breaks,



COMBUSTION CHAMBER CONTAINING FOUR ARCS.

the discharge which follows produces ozone almost entirely. The flame is now brought to its most efficient form as quickly as possible, and maintained there while the air passes it. A pressure of 33,000 volts is the potential employed, obtained by transform-



THE EXPERIMENTAL LABORATORY, SHOWING THE COMBUSTION CHAMBER, THE COMBINING VESSELS AND THE DISSOLVING TOWERS.

ing the 220-volt 60-cycle lighting current. A form of spark gap on the principle of the horn arrester is used with electrodes diverging upwardly. The spark

One illustration shows the flame. The travel of the spark up the electrodes is shown by the bright spots, due to the alternations. There are about twenty of

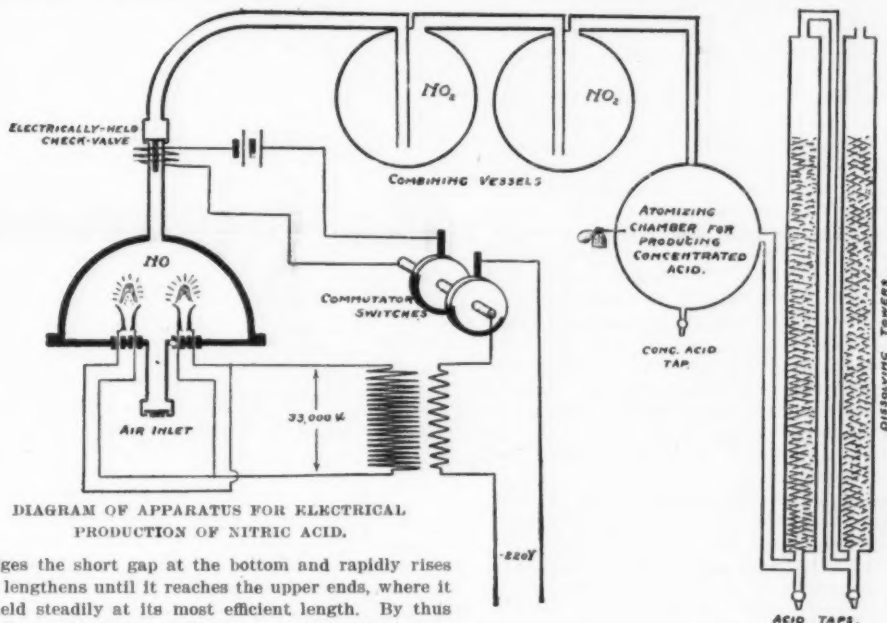
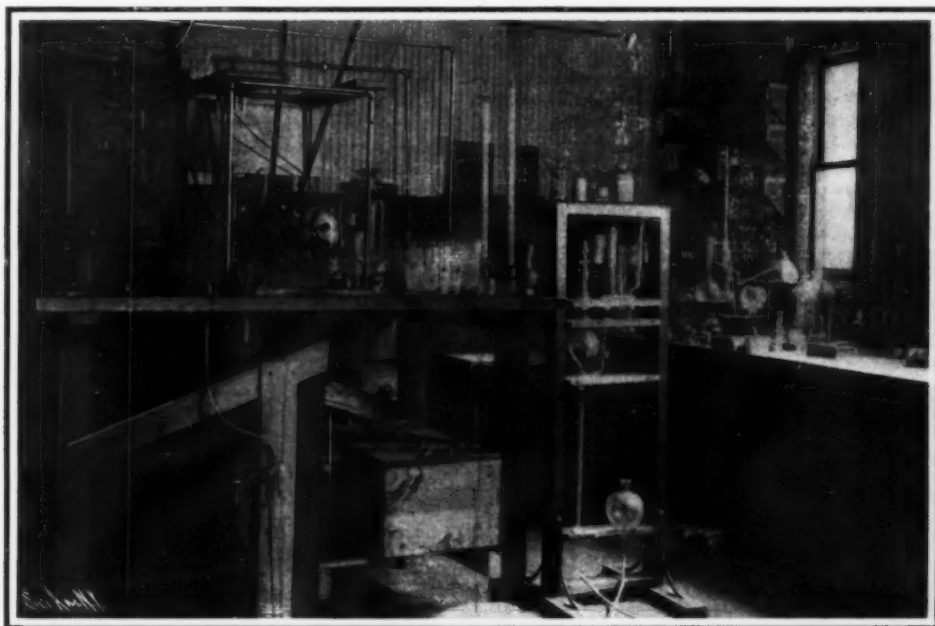


DIAGRAM OF APPARATUS FOR ELECTRICAL PRODUCTION OF NITRIC ACID.

bridges the short gap at the bottom and rapidly rises and lengthens until it reaches the upper ends, where it is held steadily at its most efficient length. By thus rapidly reaching the condition of greatest effectiveness it is found that under identical conditions the steady flame produces four times as much nitric oxide as the older forms.

these spots, each the positive end of a spark, and as a 60-cycle current is employed the twenty spots show that the spark ascends in about one-third of a second.



ANOTHER VIEW OF THE LABORATORY.
THE MANUFACTURE OF NITRIC ACID FROM THE AIR.

Having investigated the flame, the experimenters turned their attention to the air supply. The rapid current of air formerly favored has been abandoned, and now a volume of air is kept in the chamber containing the flames, being held by an arrangement of valves. The advantage of this is that the rise in temperature of the air merely increases its pressure instead of rarefying it, and so the molecules are kept in contact with the flame, instead of expanding away from it.

The apparatus is also illustrated. The air is admitted through a valve into the hemispherical combustion chamber, where it is acted upon by four flames. Two commutator switches, differing by a few degrees, control the outlet valve and the transformers supplying the flames respectively. The four transformers are not shown in the diagram; they are placed under the table on which the combustion chamber rests. The valve circuit is broken just before the flames are put out, and the gases, under the heat pressure, escape to the combining vessels. When the flames are extin-

guished the temperature in the chamber falls, and fresh air rushes in through the inlet. The expansion of the gases as they leave their chamber absorbs nearly all the excess heat, and the gases reach the combining vessel only a few degrees hotter than the air from which they have been taken. The gases which leave the combustion chamber are nitric oxide, free nitrogen, and free oxygen. In the combining vessels, oxygen and nitric oxide combine to form nitrogen peroxide. From the combining vessels the gases pass to the dissolving towers where the nitrogen peroxide dissolves, forming nitric acid, and the free nitrogen escapes to the air. We have said that by a careful study of the best form of flame to be used the inventors increased the value of the flame fourfold; and equal gain has been made by the intermittent method of feeding and imprisoning air, as against the earlier method of using a rapid continuous current.

Another important question has been the excess nitrogen produced and wasted. The gases have left the

combustion chamber in the proportions of four parts of nitrogen to one of oxygen, and the surplus nitrogen has bubbled up through the dissolving tubes and escaped to the air. If the chamber could be fed with equal, instead of disproportionate amounts of oxygen and nitrogen the yield of nitric acid would be much increased. This, of course, has long been recognized, but the problem has been to get a supply of cheap oxygen. This the inventors have now achieved.

When the nitric acid is obtained, any other nitrogen compound may, of course, be manufactured. The acid obtained is pure, and as the raw materials are air and water, one of the largest usual items of cost in manufactures is avoided. The inventions which have made this nitrogen recovery practical are due to the investigations of Mr. W. M. Thomas, of Chicago, assisted by Mr. G. Barry. An experimental plant has been in successful operation for some months, and now a factory is being fitted for the production of nitric acid on a large scale.

THE STORY OF WHEAT. THROUGH MILL TO MARKET. BY CORNELIA KENNEDY.

As preparations of flour form the staple food of all civilized communities, the cultivation of wheat and the manufacture of flour are necessarily industries of the greatest magnitude and importance. The cultivation of wheat was one of the earliest developments of human civilization, and there are many records showing that the primitive races made use of the grain by pounding it into a coarse flour.

When people first began to grind their grain they did so by crushing it between two conveniently flat stones, and as this was part of the domestic arrangement in the preparation of food, it was done by the women of the household. A little later stones were kept especially for this purpose, one of which was made stationary, while the other was moved around on the top of it by means of a handle. Down to the early Roman civilization, grinding was still a household art, but from then on, as the manner of living became more complicated and the principles of economics unconsciously developed in the mind of man, it gradually became the custom for one person to do the grinding for a community. From old tablets and vases of this period we know that hand mills of cylindrical form were used, and later still power mills, the power being furnished first by horses and then by wind, and still later by water. From this period, for many centuries—although many devices were gradually invented for grinding and sifting—the development of the mill was slow, and, indeed, the mill and miller figured more prominently in art, poetry, and romance than in the making of food for man.

In the first part of the nineteenth century rapid advances in construction, not only of the mill buildings, but also in the inside appliances, began. The work of pioneers in the development of steam engines gave a great impetus to the millwright trade, and to the efforts of many men is due the perfecting of the millstone mills. The clumsy and ill-balanced wooden wheels made way for iron ones, and inside the mill lighter and more accurately fitted gearings replaced old forms.

From the middle of the century up to 1880 each year saw improved devices for driving, setting, balancing, and adjusting the stones. Blasts and exhausts were introduced to do away with the heat caused by friction of the stones. Silk cloths replaced the linen bolting cloths, and bran dusters made their appearance. The old-fashioned low milling process, or grinding between stones placed very close together, and afterward bolting the product, was replaced by the high milling process with stones far apart, thus allowing the middlings to be purified before being ground into flour.

This gives briefly the development of the ancient hand-mill or quern from its earliest and crudest conception to the highest form of perfection.

Some forty years ago a man in Buda-Pesth began to operate the first roller mill, which method of milling was to revolutionize the entire system, for it permitted a more perfect separation of the different parts of the wheat and the entire separation of the bran and germ from the floury portions.

An examination of the structure of a grain of wheat shows how difficult it is in preparing the wheat for milling to remove all dirt from the berry. The kernel of wheat consists of two lobes separated by a longitudinal crease. The hairs on the end of the berry, and the fine dust adhering to its coat, are easily removed by brushes and friction, but it is impossible to remove the dirt inclosed in this crease. By the stone mill process all this dirt was mixed with the flour and middlings in the first grinding. By the roller mill system this difficulty is overcome, as the berry is split along the crease and the dirt removed by brushes.

As the wheat is unloaded at the mill it is weighed by a state grain inspector and then conveyed to the top of the wheat-house by means of an endless belt carrying many small buckets to hold the grain. Here the wheat is cleaned, for when brought to the storage bins in the mill it contains much foreign substance in the shape of dirt, chaff, and seeds of weeds, and other grains that have grown in the wheat fields. These are all removed by what is known as the milling separator, a series of metallic sieves aided by drafts of air and suction. The first set of sieves has perforations just large enough for a kernel of wheat to pass through, and, therefore, oats, straw, and everything that is larger than a kernel of wheat pass over. Many smaller seeds, as mustard and cockle, are still left in the wheat, and therefore, the next set of sieves contains perforations much smaller than a kernel of wheat, through which these small seeds pass. Strong currents of air are continually passing through the box containing the sieves, so that much of lighter impurities, such as shrunken wheat, light-winged seeds, and dust, are carried off into the dust collectors.

From the separator the wheat is next passed through what is called the wheat scouter. This is an upright perforated cylinder in the center of which, revolving about a shaft, are brushes which not only brush most of the dirt from the crease in the berry, but also serve to throw it against the sides of the cylinder, which wears off some of the outside covering of the berry, and all the dirt and fuzz. There is also a strong current of air passing upward through this cylinder to carry off the dust from the scouring. The wheat is now bright and clean and ready for tempering.

Tempering is accomplished in various ways, for each miller has his own theories as to how the best results can be obtained. If the wheat is too hard, the operation is intended to soften it; if too damp, to dry it; if it is too brittle, to toughen the bran, so that in going through the rolls the bran will flake out instead of grinding up in a fine powder and mixing with the middlings.

After leaving the scouter, the wheat is next conveyed to large heating cylinders, where the grain is carefully heated so that it will absorb the water used in tempering more rapidly. From these heaters it is conveyed through troughs by means of a screw, while small jets of water trickle down upon it. The wheat thus dampened remains in the tempering bins for from two to three hours.

A method of tempering which is much used, especially when a wheat is very dirty, is that of washing. Some millers use this means entirely, while others wash a certain portion and treat the remainder as described. Before washing, the wheat passes through the separator, which is a machine combining water separator, stoner, washing and centrifugal drive, all in one. The wheat enters the machine through the feed hopper, which contains water and which regulates the feed to the machine, by an adjustable slide which spreads the wheat in an even and regular stream of grain. This enters the stoner spout, where it meets an upward current of water. Stones and all substances heavier than the wheat settle against the current of water and the wheat enters the overflow tank, where all lighter material, such as smut balls, straws, etc., pass out with the overflow. The wheat sinks in the tank and passes through a valve in the bottom, into the washing cylinder, where it is thoroughly washed and discharged into a perforated cone, and where by centrifugal force the wheat is freed from an excess of water, and carried by flexible flights attached to the cone out of the washer. It is then conveyed to the driers.

These driers consist of two concentric galvanized iron cylinders, a smaller perforated one inside of a larger one. There is a space between the two cylinders of about an inch and a half to two inches, for the passage of the wheat. As the wheat passes slowly from the top to the bottom, air is forced into the inner cylinder, and through the perforations, into the wheat. The cylinder is arranged to contain two air chambers, one hot and one cold, so that the wheat is first dried by air at about 190 deg. Fahr., and then cooled by the cold air in the lower chamber.

In tempering, the miller needs to observe most carefully the condition of his wheat, the amount of water used and the temperature of the air or steam, for the danger of over-wetting and over-heating is very serious, changing as it does the chemical composition of the wheat. If the miller has not learned by experience to judge approximately the percentage of moisture in his wheat, he should make this determination by exact test, and then add just enough water so that the resulting flour, which, it is to be remembered, loses several per cent of moisture during the process of manufacture, shall contain the desired proportion of water.

Different samples of wheat demand different treatment, but there is really nothing which the intelligent miller may not overcome by careful thought and application.

After tempering, the wheat is ready for the first rolls or break. Before entering the rolls each pound of wheat is weighed in an automatic dump scale. These scales hold thirty pounds of wheat, and as they dump this amount it is registered, thus recording the amount of wheat ground in the mill.

The theory upon which the gradual reduction process is based is that in order to obtain the greatest yield of high-grade flour the maximum yield from the breakers must be middlings. For it is easily seen that if the berry is completely crushed in the first break a great deal of dirty flour is made which must be passed to the lower grades.

The success with which this operation of gradual reduction is carried out depends greatly upon the corrugation of the rolls, and the way in which the rolls themselves are set. The corrugations resemble very nearly the outline of a saw tooth, and instead of running lengthwise of the roll they run toward a spiral. Beginning with the first roll, there are about ten to the inch, the number increasing with each set of rolls, up to about twenty to the inch. If the rolls ran at exactly the same speed the tendency would be to crush the berry rather than to break it and free the bran from the endosperm. To prevent this, differential speeds are used. This increase in velocity of one roller surface as it travels over that of another practically shears the wheat and aids in the rapidity of reduction.

The theory of the first roll is that the wheat berry is split along the longitudinal crease, and that the grain is sheared of its outer coats. The splitting of the grain holds only in theory, for the greater number of kernels passed through the first break are broken into irregular shapes. But the bran is flaked out and contains a part of the endosperm, which is gradually removed in the remaining breaks.

The product from the first break goes into the scalp-ers, which free the loose floury portions from the bran. The scalp-ers are of various forms, but those in the form of a sieve, having a gyrating motion, with a wire gauze of No. 20 mesh, give the most satisfactory results. The tail, or what goes over the end of the scalper, goes to the second set of rolls, or the second break. These rolls are set up a little closer, and the corrugations are finer than the first break. The prod-

net from these rolls goes to another scalper and is separated as above. In all, this process is repeated five times. In some mills there are six breaks, but after passing through five the endosperm is so entirely free from the bran that nothing is gained by further reduction. The middlings from the first two breaks are large, and in themselves are clean, angular fragments of endosperm, but are mixed with a considerable amount of bran and germ. The middlings from the succeeding breaks become finer and are mixed with a greater or less amount of dust and fine particles of bran and germ.

If a section is made of a kernel of wheat, we see directly under the aleurone layer the cells containing the gluten. Going toward the center of the berry we find these cells softer and containing more starch. When the berry enters the rolls this soft portion is the first to grind down, and as it contains a very large percentage of starch, and also as it is dark-colored, because being in a finely divided state it absorbs any dirt that may be present on the bran, it must be put into the lower grades.

As stated above, it is the aim of the gradual reduction system to make as little of this break flour as possible. However, more or less is made in the various breaks and is separated from the middlings and bran and run into the lower grade flours.

After leaving the scalpers, the middlings, which still contain much foreign substance, must be divided into various grades, with respect to size. This is accomplished by running all the middlings into a sizing or grading machine. In old mills this is in the form of a reel, but later patterns are made in the form of a box, containing sieves covered with various sizes of bolting cloth, the whole having the usual gyrating motion. The middlings enter this and are run onto the finest cloth, which sifts out the flour. What will not pass through this cloth goes over the end onto a little coarser cloth, and so on down until the middlings have been divided into about eight grades. The coarsest are called No. 1 middlings. Under the sieve are devices for throwing the middlings into one stream, or separating them to suit the convenience of the miller.

Before the various grades can be ground into flour they must be purified. This is done in the middlings purifier, which is a long, narrow sieve with a strong current of air passing upward through the cloth. This sieve is placed in a slightly inclined position, and moves rapidly backward and forward. The middlings travel from one end of the sieve very gradually to the other end, the strong current of air carrying off the fine dust into a dust collector, and the fine bran, being lighter than the middlings, is suspended above the cloth by the air current, while the middlings go through. The coarser bran is carried by the current of air to the tail of the machine, and is thus separated from the middlings. The fine flour which is carried to the top of the box by the draft is collected by a device which moves slowly along the top, catching the flour as it moves and dumping it over a slide at the end. Each grade of middlings is purified separately. Some bits of bran and germ will still cling to the middlings, which in the first roll are flattened out into small flakes and are easily separated by the sieve.

The success with which the operation of purification is carried out depends chiefly upon the kind of wheat milled, the thoroughness of cleaning, and the condition of the middlings themselves. Hard spring wheats produce middlings best adapted for purification. The bran of these wheats is usually thin and splinters off into short flakes, which are easily separated by the air drafts, and the hardness of the wheat makes possible clear, bright middlings mixed with very little flour. With soft wheat the tendency is to wear away when reduced to middlings, with the formation of much dust flour. The bran is also tough and requires greater force to separate it from the starch cells, which tends toward producing fine floury middlings.

The importance of thoroughly cleansing wheat before reducing cannot be over-emphasized, for any dirt which is left on the berry, or foreign seeds, will show up in the form of black specks in the middlings. And, further, the condition of the middlings themselves is a most important factor influencing the success of purification. The careful miller is not satisfied to know that he has made a good selection of wheat and carefully prepared it for milling; he must also know that his rolls are sharp and properly set. Dull rolls produce middlings with no sharply defined edges, mixed with a great deal of fine floury substance which it is almost impossible to separate in the various processes of cleaning. It is also well to remember that the purifier cannot give good results unless its sieve is evenly covered with middlings at all times.

After the middlings are thoroughly purified they are reduced, similar to the gradual reduction of wheat, on smooth rolls to flour. The coarsest middlings are ground on the first set of smooth rolls and the product passed to a reel clothed with fine silk bolting cloths. What goes through the various cloths is conveyed to the flour bin, while the tailings are sent to the second rolls, which are set up a little closer than

the first rolls. This process is carried on for all grades of middlings, each going through different sets of rolls and sieves, and from the various streams the different grades of flour are made.

Some mills still use millstones in part for reducing the pure middlings to flour. Claim is made that the natural grit of the stones cuts the granules into sharper flour. Others use only the roller system, claiming the results are the same, that less power is needed to drive the rolls, and that the expense and skill necessary to dress the stones are entirely obviated. Whichever method is used, the same system for the final bolting is employed.

Before following the course of the flour to the packers, let us stop to examine the bolting cloths used in making the various separations. Hardly a generation ago the best grade of flour came through a wire gauze of No. 60 or 70 wire. Linen bolting cloths were the next step in improvement, and finally, a little over a quarter of a century ago, silk cloths began to be used.

All the bolting cloth used in our American mills is imported, the greater part of it coming from Switzerland, where the art of manufacturing it has reached the highest perfection, and where, too, a particular water is obtainable which assists greatly in finishing it. The cloths are numbered according to a purely arbitrary system, the numbers 0000 to 21 having no relation to the number of meshes. When the industry was first introduced into Switzerland, in the year 1830, bolting cloth was made in ten different sizes, which for convenience were numbered 1 to 10, but gradually, as improvements in milling machinery and the development of the milling industry in general demanded it, other sizes were added in both directions, the coarser numbers being called 0, 00, 000, 0000, and the finer ones 11 up to 21. To ascertain the number of a piece of cloth the warp threads, that is, the threads running lengthwise of the cloth, must be counted.

Six grades of cloth are usually made, each grade being intended for a certain service, and it is for the miller to select the quality best adapted to every machine and operation. By using good judgment in this respect he can save considerable expense. Some millers give preference to the lighter grades, asserting that the quicker wear is amply compensated by closer separations and fine bolting; others consider it more economical to purchase the heavier grades because they last longer. Experience has taught, however, that the heavier grades are preferable for hard wheats and the lighter grades for soft wheats.

Having passed through the fine silk cloths of the various dressing machines, certain streams, according to the flour to be made, are united and run into a vertical chute, from which it runs into the sacks or barrels in which it is shipped to the consumer.

During this whole process of milling, from the time the wheat enters the weighing scales until the bags or barrels are loaded on the train, the hand of man has not come in contact with any portion of wheat or flour.

To a visitor at the mill the rapidity with which the work of packing is accomplished is marvelous. The flour rushes down the chute, is caught in a sack, accurately weighed, and passed to a sewer who has secured the top of the bag before the eye can see what is being done. Some of the sacks are sewed in the old picturesque fashion with the two ears standing upright at the corners, but many are sewed by machine, because of the rapidity and ease with which the operation can be done.

This completes the actual process of milling. In a short paper of this kind it is impossible to enter into detail concerning each product made, for from the time the wheat enters the mill until the finished products are offered for sale, the whole number of products formed is from eighteen to one hundred. All of these are not placed on the market, it is understood, but are used in making the final products. Each of the one hundred streams are carefully watched and tested from time to time by the miller, who is so expert that he can easily tell by feeling of the stock just what his rolls and purifiers are doing.

Each miller has his own methods for obtaining the final results, so that percentages in every mill vary, but in general it can be said that 75 per cent of the weight of the wheat is obtained in a merchantable flour, of which from 60 to 65 per cent is high-grade patent.

The by-products of a mill form an important class of animal feeds, and represent about 24 per cent of the weight of the wheat used.—Pure Products.

CANNED MEATS.

In a paper before the International Congress for Hygiene and Dermatology, held in Berlin, Dr. Dosquet-Manasse called attention to the fact that, by the present method of canning meats, etc., we obtain, it is true, desirable products, but that they are not free from germs and products of decomposition. There has, however, been a great improvement in the canning industry since the change from the old antiseptic process, which altered the natural properties of the meat, to the new aseptic method.

According to the experiments of Dr. Dosquet, the meat is, while in the steaming boiler, perfectly free from germs. The difficulty is that in its progress from these boilers to the cans it becomes again inoculated. It is, however, possible to prevent this reinfection, by conveying the still hot steamers through a large tubular passage into a room in which the air has been filtered free from germs. In this room, exposed only to filtered air, a special machine cuts the meat into regular pieces, weighs it, and fills it into previously disinfected cans. By this process it is possible to can meat so that it retains its full flavor; to work up the cheap meat of the German colonies, and to hasten the process of packing, which is, of course, of great importance to the army and the navy.

OIL FIELDS OF THE UNITED STATES.

The areas in the United States producing petroleum and natural gas in commercial quantities are comprised within five great fields and a few smaller scattered tracts, the division into fields being governed by the location of the areas and the quality of the oil produced. These fields are known as the Appalachian field, the Lima-Indiana-Illinois field, the Mid-Continent field, the Gulf field, and the California field.

The Appalachian field extends along the western side of the Appalachian Mountains from New York through Pennsylvania, southeastern Ohio, West Virginia, and Kentucky into Tennessee. The oil is derived from porous sandstones and conglomerates, which are embedded in and underlain by great masses of shale. The oil of this field has a paraffin base and is of the very best quality.

Within the last few years the production of the Appalachian field has dropped from over one-half the total production of the United States to less than one-fourth, not so much by falling off in the output of the field itself as by the great increase in the quantity of oil produced in other parts of the United States. In 1906 the total production of the field—27,741,472 barrels—was 8,553,961 barrels less than that in 1900, the year of greatest production.

The Lima-Indiana-Illinois field includes the northwestern part of Ohio, a strip through the middle of Indiana, and the southeastern part of Illinois. The productive rock in this field is the Trenton limestone, which is from 400 to 600 feet thick, but the oil is derived only from certain portions of this formation, whose structure or relative elevation is the governing factor in the accumulation of the oil or gas. This field furnishes oil that has a paraffin base but contains a percentage of sulphur. In 1906 it produced 21,951,711 barrels of oil, or 523,544 barrels less than in 1905.

The Mid-Continent field includes the western part of Missouri and the States of Kansas and Oklahoma. It produces oils with a mixed asphalt and paraffin base. These oils differ greatly in quality, their specific gravity ranging from 18 deg. to 40 deg. Baumé. They are dark in color and carry some sulphur.

During the last four years the Mid-Continent field has become the most important in the United States. The present value of the oil product of the field is not greater than that of some of the other fields, but the developments indicate continued expansion of the producing area, the discovery of more pools, and finally a better price for the oil. The production of this field in 1906 amounted to 21,718,648 barrels, an increase of 9,705,153 barrels over the output in 1905.

The Gulf field lies in the Coastal Plain part of Texas and Louisiana. The oil, much of which has an asphaltic base, is derived from beds of sandstone and dolomitic limestone. The great porosity of the reservoir rocks makes the initial flow of the wells very large and the life of the wells correspondingly short. This oil is suitable for use in the manufacture of lubricants and as fuel. In 1906 the Gulf field produced 21,645,425 barrels, a falling off of 41.6 per cent from the production of 1905, the decrease being due chiefly to the smaller production in southeastern Texas.

The California field, so far as developed, lies mainly in four counties—Kern and Fresno in the San Joaquin Valley, and Santa Barbara and Los Angeles near the coast. Some oil pools occur in Ventura, Orange, San Mateo, and San Luis Obispo counties, but these furnish a comparatively small part of the production of the State.

The conditions under which the California oils occur make well drilling difficult and expensive. The oil-bearing formations are very thick and are generally soft, so that the casing must immediately follow the drill. About Coalinga, wells between 2,000 and 3,000 feet deep cost between \$20,000 and \$30,000.

The California oils show a wide range in quality and include large quantities of oil with asphalt base. Much of the oil is used as fuel. The production in 1906 was 33,098,598 barrels, or 328,875 barrels less than the production in 1905.

Small quantities of oil are produced annually in Wyoming, Colorado, and Michigan, and indications of oil but no actual production are reported in other States. The most promising of these minor oil fields is in Wyoming.

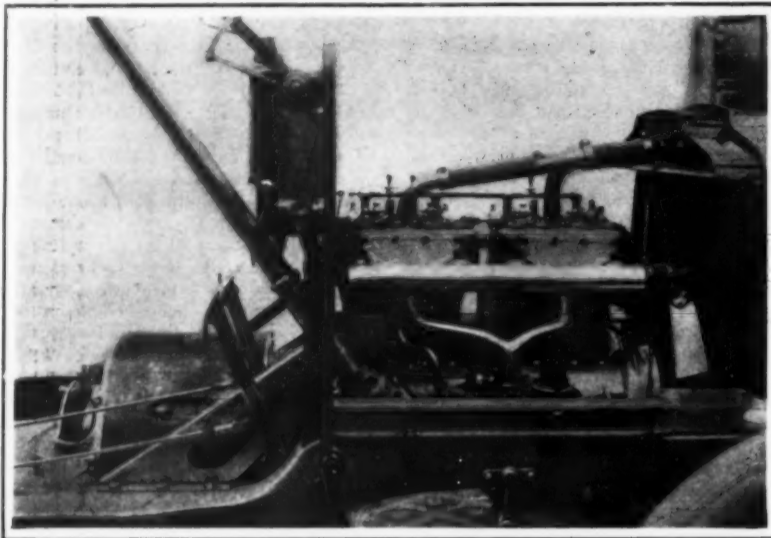
CARS AND NOVELTIES AT THE TENTH ANNUAL PARIS AUTOMOBILE SHOW.

As this was the tenth annual automobile show which had been held at Paris, the organizing committee made special efforts to have a brilliant display this year. In order to accommodate the exhibits which could not find room in the Grand Palais, an annex of unusual size was erected in the adjoining grounds of the Invalides, just across the Seine, and here were placed most of the heavy-weight cars, machine tools, and stationary motors. In the main central space of the Grand Palais were represented the well-known automobile firms of France and other European countries, with the former greatly in the majority, however. As was to be expected, there was a great profusion of chassis, motors, and complete cars to be seen, including both the heavy cars and those of the light weight variety. Of the latter there were many chassis and cars on view, and in some of these the effort of the manufacturers to reduce the price of the four-seat car as much as possible and to design a popular type was clearly apparent. As to the voiturettes, the prices are naturally much lower. As regards the number of exhibits, this was considerably greater than last year. Some of the leading firms had a second exhibit in the Invalides Annex, consisting of heavy hauling cars or stationary engines. The total number of exhibits at the show was nearly seven hundred. The section of machine tools was one of the features of the Annex, and there were a considerable number of special tools for manufacturing automobile parts. It was decided this year to remove the motor boats entirely from the automobile show, so as to provide the space which was needed for the regular exhibits. Accordingly a separate exhibition of motor craft was organized in a large building in another part of the city.

The fact that the German Mercedes firm is bringing out a combination gasoline and electric car seems to show that they have considerable faith in the future of this class of automobile. This new model is built in two sizes, one of these being a 40-horse-power and the other a 60-horse-power. It is intended to combine all the advantages of a gasoline car on the one hand, and an electric car on the other. The electric transmission gives great simplicity and progressive starting and speed control, with silent running, while a great radius is obtained by the use of the gasoline motor. In the Mercedes-Mixte, as it is called, many of the parts of the usual gasoline car are suppressed, such as the clutch, change-gear box, and differential, as well as shaft or chain drive, and numerous mechanical parts, levers, etc. On the front of the chassis is mounted a four-cylinder gasoline motor of the company's most recent type, provided with an automatic carburetor and thorough lubrication by means of a special oil pump and a set of oil feeds which are operated by eccentrics from the motor. A honeycomb radiator, with its pump, completes the motor outfit. In place of the flywheel back of the motor, there is a dynamo which is located directly upon the motor crankshaft. This dynamo, which runs at the speed of the motor, is designed so as to avoid sparking and undue wear. The current generated by this machine is sent to the controller, which is placed under the

and none of it is wasted in resistance coils. A quick-break switch operated by a lever is used for emergencies, as for a rapid braking of the car. Owing to the use of the two separate motors, a differential is not required for the rear axle. The latter is stationary

system of construction, using two side-bars of nickel steel stamped in the press, and these are connected in the rear by a cross-bar of the same metal and in front by the block which is formed of the motor and gear box. The whole gives a great resistance to bending



POWER PLANT OF THE KRIEGER GASOLINE-ELECTRIC TAXIMETER CAB.

The dynamo is seen at the left, on the end of the engine crankshaft.

and each of the wheels with its motor is entirely independent.

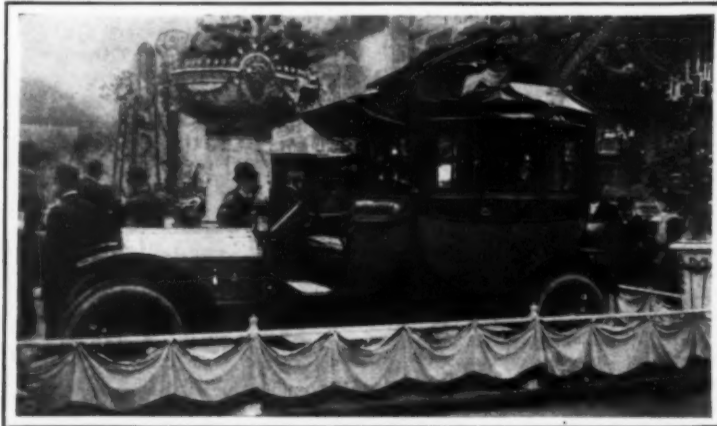
Automobile cabs are now coming into use in Paris, and are proving quite a favorite with the public. The "taxautos," as they are called, are provided with the new mileage counter which has been already quite a success on the horse cabs. Some of the automobiles are of the usual gasoline system, while another type which is used is the Krieger gasoline-electric system. Some of the latter were to be seen at the show and they are well designed and roomy. The 14-horse-power Krieger chassis is used in the present case, with an independent electric motor placed on each of the front wheels. We have already had occasion to describe this system in detail, and it has been somewhat improved this year. As regards the fare to be paid for the cabs, the mileage counter is worked by a flexible shaft from the rear wheel, and registers \$0.15 for the first kilometer (0.6 mile) and \$0.02 for each 250 meters after this. When the cab stops for any length of time, the driver pushes down a lever which sets a clockwork movement going, and this also moves the rate-indicating wheels according to the time. On starting up the cab, the lever is lifted and the first mechanism comes into play. The Darracq firm also exhibited a gasoline car of standard make, adapted to a cab body for city use. There are two types made, one of these being a 12-horse-power with a two-cylinder motor, and the other a 16-horse-power with a four-

and the mechanism is naturally protected without requiring a sheet-iron under-piece. A four- or six-cylinder motor with cylinders cast in pairs is used here, with nickel-steel valves situated symmetrically on each side of the motor, these being interchangeable. The crankshaft of chrome-nickel steel has all its bearing parts rectified after tempering. A water pump and honeycomb radiator of the usual kind are employed, but in this case there is an air fan mounted between the motor and the radiator so as to secure an extra draft. The fan is run by belt from the motor. The present car is built in 40, 50, and 70 horse-power sizes.

The De Dion-Bouton firm had a very handsome display this year. This company's line of 8 to 30-horse-power cars are built with a view of securing the low-price trade. For instance, a 4-passenger automobile of double phaeton or tonneau form has a chassis which sells as low as \$1,000. This is an 8-horse-power car with single-cylinder motor—a reversion to the original De Dion type. As to the 12-horse-power type, it has a 4-cylinder motor (3-inch bore and 4-inch stroke) and a stamped steel chassis. The motor has mechanically operated valves and magneto ignition, with an automatic carburetor of recent design. A multiple disk clutch is used in connection with a 3-speed sliding gear transmission. Shaft drive is also employed on the De Dion cars. The 30-horse-power car has a 4-cylinder motor and four speeds with direct drive on the top speed.



SIX-WHEEL DARRACQ-SERPOLLET STEAM OMNIBUS IN USE IN PARIS.



DARRACQ DILIGENCE WITH STAGE COACH TYPE OF BODY.

SOME NOVEL LARGE CARS AT THE TENTH ANNUAL PARIS AUTOMOBILE SHOW.

driver's seat and operated by a lever located beside the hand-brake lever. The controller gives different electric couplings to obtain the different speeds. On the rear wheels of the car are mounted the two motors, which are of the circular type, built directly into the middle of the wheel, and using a flange expansion of the motor to support the rim of the wheel. The controller gives six speeds ahead and one reverse. All the current from the dynamo is used in the motors

cylinder. Shaft drive with a three-speed sliding gear transmission on the rear axle is used.

Among the new cars was noted one of the first cars of Spanish manufacture, the Hispano-Suiza. There were several handsome chassis and complete cars of this make to be seen at the show. The King of Spain has been using one of these cars for some time and has expressed his satisfaction with it. The chassis is made extra solid on what is known as the "Birkigt"

The Mors company has brought out a low-priced car of the 10-horse-power type which has three speeds and carries a 4-cylinder "Monobloc" motor. Cam-driven valves are fitted; also a new carburetor with double atomizer and auxiliary air valve, as well as a gear-driven water pump, and flanged tube radiator. Pressure-oiling by the use of the motor exhaust, and an all-metallic clutch are also among the features to be noted. There are also shown 20, 28, 45 and 50

horse-power cars, some of which use shaft and others chain drive. All of them have stamped steel chassis.

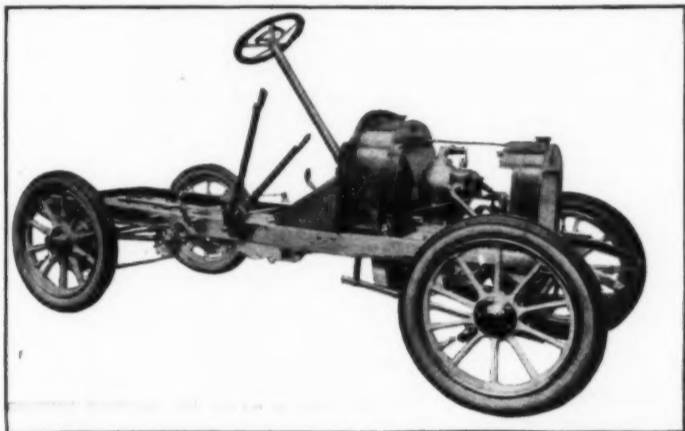
The new 1908 Charron cars also attracted considerable attention. While the heavier cars are built in 75 and 50 horse-power sizes there is also a 15-horse-power light chassis which has some good features. An innovation with this firm is the placing of the steering wheel on the left side. The motor has the four cylinders cast together *en bloc*, which simplifies the question of piping and reduces the number of joints, while making all the parts readily accessible. Both inlet and exhaust valves are operated by the same camshaft. There are two ignition distributors, one for the magneto, and the other for the storage battery. The friction-clutch is combined with the air-fan, and is provided with a small brake acting on the cone in order to reduce the wear on the teeth of the gears when changing speeds and to avoid the danger of stripping. The gear box is of an improved form with ball bearings throughout. The propeller shaft is inclosed in a casing which runs to the rear axle, and the joint of the rod has a new method of oiling which consists in bringing the oil from the gear-box through a central hole bored in the direct-drive shaft of the box, whence it is distributed to the different parts of the joint.

The new Hotchkiss cars were also remarked among the most prominent at the show. They are built in

power. All the cylinders are cast separately, and they have a 110-millimeter (4.4-inch) bore and 120-millimeter (4.7-inch) stroke. The same firm also makes a 4-cylinder motor giving 20 horse-power, and a larger size for 30 horse-power, the latter having the same cylinder dimensions as above. A universally-jointed driving shaft is fitted.

As to the 4-cylinder motors, they are to be seen in great numbers. Besides the new 80-horse-power Pipe motor, there was also noted on exhibition the 50-horse-power Charron motor. It has four separate cylinders, which, however, are placed very close together so as to give great strength and avoid vibration of the crankshaft. The eight valves, which are cam-driven from a shaft above the cylinders, are located in the cylinder heads and thoroughly cooled. The cooling has been specially designed, so as to allow this high power type to be used at high speed upon the road as well as at slower speeds within the city, and it is carried out by means of a radiator of large surface, fed by a water tank which is placed in the rear of the chassis. The water pump is driven by the exhaust camshaft through special gears of a high ratio. A fan is combined with the flywheel. With respect to the new De Dion 4-cylinder motors and their chassis, these are now built in sizes ranging from 12 to 30 horse-power. The latter has a 110-millimeter (4.4-inch) cylinder bore and 130-millimeter (5.2-inch) stroke. The chassis

is built of pressed steel. In the 30-horse-power size the motor has cam-driven valves throughout and double ignition by magneto and coil. The friction clutch is of the all-metal disk type and is worked by a pedal. Four speeds and reverse are secured by the same lever, with direct drive on the top speed. A universally-jointed driving shaft is used.

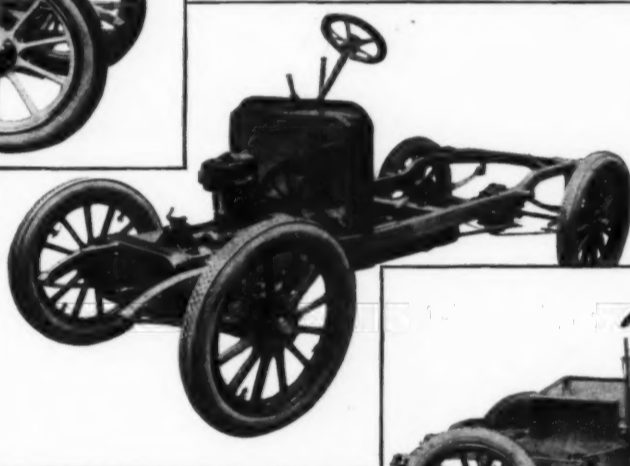


9-HORSE-POWER PEUGEOT VOITURETTE CHASSIS FITTED WITH DOUBLE CHAIN DRIVE.

sizes ranging from 55 to 20 horse-power. A 6-cylinder motor is used for the heaviest car, but in all the others a 4-cylinder motor is employed. The four cylinders, cast in one piece, have all the valves on the same side and mechanically operated. The leather-cone friction clutch is connected to the gear box through a universal joint. From the four-speed gear box, a Cardan rod passes to the rear axle. Aside from the careful construction which is one of the points about this make, this year's model has no other specially remarkable points, although there are a number of improvements in the details. The chassis is built of pressed steel.

The voiturettes are even more numerous than ever, and most of the leading firms have turned their attention to this class of car, while other constructors are building them exclusively. We show the chassis of the new Stimula voiturette, which has a pressed steel body, of extremely strong construction. It is fitted with an 8-horse-power, single-cylinder motor with 100 millimeters (3.937 inches) bore and 120 millimeters (4.724 inches) stroke. All the valves are cam driven. The inlet valve can be regulated by a special device which allows of changing the lift of the valve by hand, and in a progressive manner. In this manner, also, the compression can be readily relieved, which allows of an easy starting of the motor. The motor has a cone clutch. The gear-box is placed about in the middle of the chassis and is connected to the rear axle through the usual universally-jointed propeller shaft. Another handsome voiturette is the Peugeot, which is also fitted with a single-cylinder motor and has three speeds, using a chain drive. The motor is designed for 9 horse-power. Some of the voiturettes of this make are fitted with shaft drive as well.

This year the number of 6-cylinder motors is on the increase, and they are to be seen at the stands of many of the established firms. For instance, the Mors company is one firm which has brought out a 6-cylinder chassis. The cylinders are cast in pairs, and all valves are mechanically operated. Ignition is carried out by low-tension magneto and also by spark coil and battery, shifting from one to the other as desired. The motor is designed for 50 horse-power. A four-speed gear box is employed, with direct drive on the top speed. The final drive is by chains to the rear wheels. One of the new 6-cylinder motors is the Porthos. These cars are made in three sizes, and the heaviest car is fitted with a motor capable of developing 50 to 60 horse-



CHASSIS OF THE "PASSE-PARTOUT" WHICH IS FITTED WITH SHAFT DRIVE.

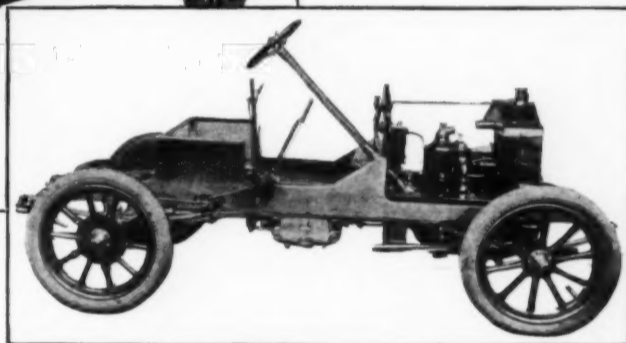
Among the new radiators, we may mention one brought out by the French Electrolytic Radiator Company. This is of the honeycomb type and is made entirely by an electrolytic process. This type of radiator has the well-known advantages of lightness and great cooling surface with small volume. It has a capital disadvantage, however, from the fact that it is formed of several thousands of small tubes soldered together. These may come apart from vibration of the car and from the different expansion of the copper and the tin solder. Thus leaks occur, and these are very hard to remedy, since the tubes cannot be readily soldered *in situ*. However, the honeycomb type still competes with the flanged tube radiator and holds its own. The company mentioned has a patented process for making such radiators in one piece. Upon a mold of fusible metal having the form of the inside of the honeycomb radiator a deposit of copper is electroplated. The metal is deposited in a smooth, even coating, making at the same time the tubes and the side frame. When the copper is thick enough, the fusible metal is melted and run out from the inside through the water-entry openings left for the purpose. The hexagonal form of the tubes, which can readily be obtained, is a great advantage in suppressing the horizontal base of the usual square tube, and the angle at the bottom of the tube gives a good water flow, and prevents the water from accumulating at the bottom when not in use. We had occasion to examine the quality of the copper which is formed by the plating process, and, owing to the improved methods used, it is not porous nor brittle. The radiator can be tested up to 7 atmospheres pressure. When the set of tubes is hammered

on the ends, the copper will bend, but does not break, showing that the process gives a metal of good quality.

AUTOMATIC TIRE INFLATOR.

A number of devices are to be seen this year for inflating tires automatically by an apparatus which is worked by the motor of the car. Some of these employ the exhaust gases, and others consist of rotary or piston pumps. But the first type has the great disadvantage of sending the burned gases into the tires, and even the best cleansing does not seem to free them from particles of carbon or oil which they carry along. As for the rotary pumps, they require a mechanical drive which in most cars cannot be easily or cheaply obtained, and often it is necessary to displace one or several parts of the chassis in order to install them. The piston pumps have also several disadvantages, and cannot always be adapted to the existing motors. To avoid these difficulties, the Michelin firm has brought out a type of apparatus which is small and light, weighing but nine pounds, and which can be placed anywhere about the motor. Besides the fact that it needs but little attention or adjustment and no oiling, it offers the great advantage of filling the tires with pure air. The Michelin device uses as motive power the air which is compressed in two cylinders of a standard motor of three, four, or six cylinders, and gives an extra compression to a part of the air, which is sent into the tire. To carry out this operation the inventor has utilized the compression of two cylinders in which the gas entry is suppressed by putting them in connection with the outer air, while the other cylinders continue to receive the explosive mixture. The connection with the air is made through a two-way cock, which can be fitted to most cylinder heads, or the motor-designers can fit on a special device for this purpose. The two-way cock consists of a round valve *d* (Fig. 5) turning within a cylinder fixed upon one branch of the motor inlet. It carries an eccentric opening which can be placed in the axis of the inlet pipe (Fig. 5) for the normal working of the motor, or else opposite an opening *O* placed in the cylinder and connecting with the air (Fig. 6).

On each of the motor cylinders the compression of which is used, is placed a cock with two outlets (Fig. 3) which are connected to the openings *A A* of the tire-filler (see Fig. 1). The latter will then receive alternately the compressed air coming from the cylin-



8-HORSE-POWER SHAFT-DRIVE STIMULA VOITURETTE FITTED WITH PRESSED STEEL BODY.

SOME SINGLE-CYLINDER VOITURETTE CHASSIS WHICH WERE THE CHIEF NOVELTY AT THE TENTH PARIS AUTOMOBILE SHOW.

ders. In ordinary working of the motor, the valve (Fig. 3) is closed at *P*, so as to prevent the explosions from coming to the tire-filler. For filling the tires, the valve is unscrewed so that it rests upon its upper seat, *N*. The orifice, *O*, serves to protect the filler by attenuating the shock of the explosions should the valve be imperfectly closed. With regard to the tire-filler, Fig. 1, this is operated as follows: The air-inlet valve is placed as in Fig. 6, with the valve (Fig. 3) open. When motor cylinder No. 1 comes to the compression period, it sends compressed air into the filler at a pressure varying between two and three atmospheres. The air arrives by the opening *A'*, upon the left face of the piston, and passes at the same time through pipe *c'*, lifts the inlet valve *a'*, and enters the cylinder *C'*. By this pressure, pistons *P*, *Q*, and *Q'*, are driven to the right and the cylinder *C* has its air compressed. At the end of the stroke, the compressed air coming from motor cylinder No. 2 arrives by the opening *A* on the right-hand surface of the piston, *P*, and passes into cylinder *C* by way of *c* and the valve *a*. The pistons *P* and *Q*, being under the same pressure, are driven to the left owing to the difference in piston surface. The air of cylinder *C'*, which is already at two atmospheres pressure, is compressed further by piston *Q'*, and when it leaves the cylinder it is at ten atmospheres pressure. When the pistons are at the

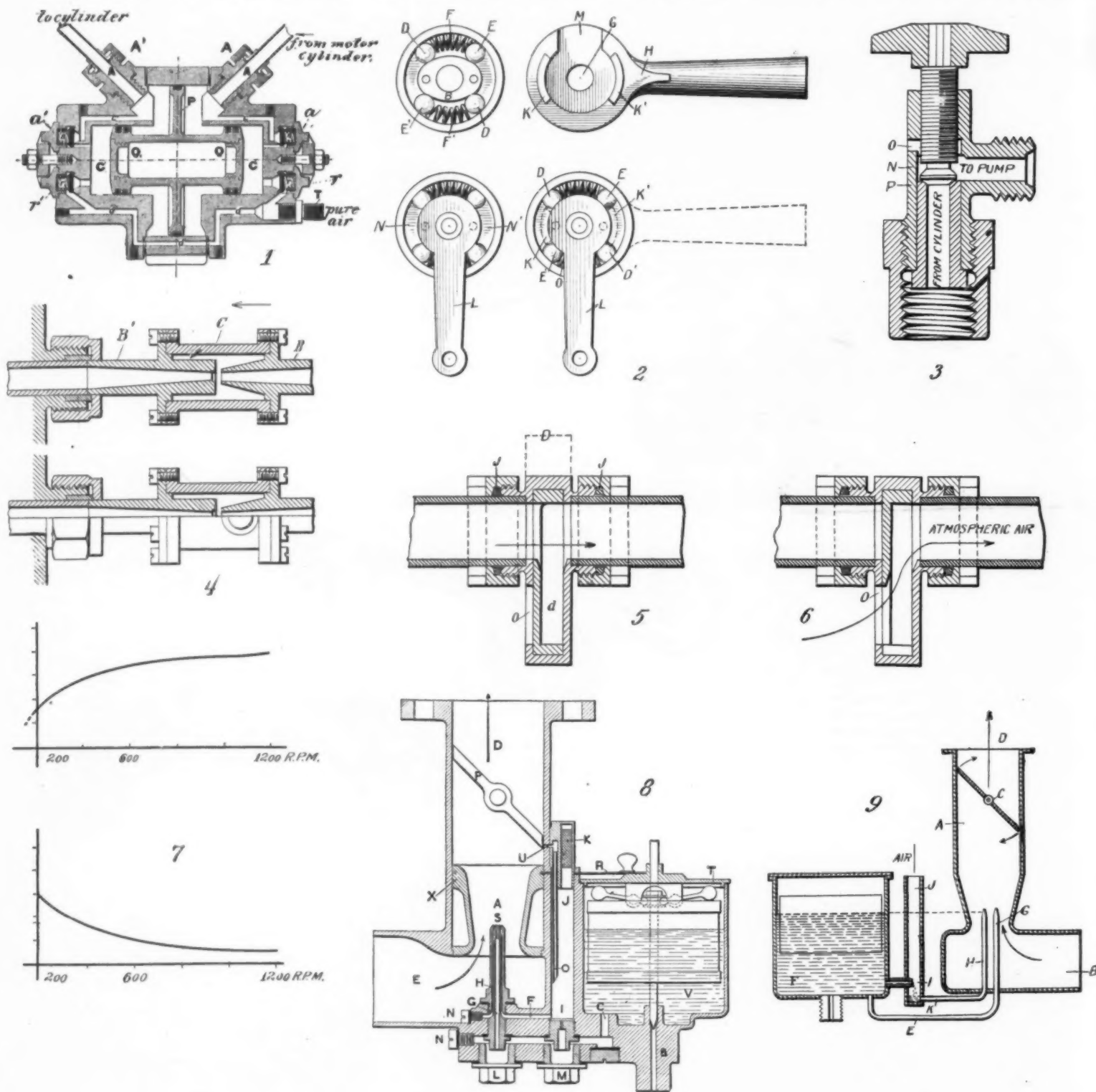
end of the stroke, the compressed air coming from motor cylinder No. 1 acts anew upon pistons *P* and *Q*, and drives them to the right. The air in *C*, which has been drawn in by the valves during the preceding stroke, is compressed, lifts the valve *r*, and enters the pipe, *T*, whence it comes out at ten atmospheres pressure. A pipe leads from here to a scrubber fixed upon the dash-board of the car, and it retains the impurities, dust, or oil which may come along with the air. A rubber piping leads the air from here to the tire which is to be inflated. A pressure gage makes it possible to see the pressure in the tire at any moment of the filling.

AUTOMATIC WATER-COOLING DEVICE.

The "Rex" water-cooling device for motors is a

effect, it tends to make a vacuum in the cylindrical chamber by aspiration of the air. Upon the side of the cylinder there is placed an expansion valve. The outer air is drawn by the depression in the cylinder into the expansion valve, and its expansion in the vacuum chamber causes its temperature to be lowered considerably. The air which is thus cooled is drawn along with the water by means of the jet and is intimately mixed with it, thus cooling the water quite effectively. When it is desired to use the cooling apparatus upon motors which have a constant speed, such as is the case with stationary engines in general, it is sufficient to place one of these aspirating jets in the path of the water circulation; but for automobile motors, where the work done varies constantly,

started with ease when cold. The mechanical devices which are used upon most modern carburetors are nearly all designed to open an air inlet, but these are liable to get out of order and they are difficult to adjust accurately. The reasons for needing this air regulation are as follows: In an ordinary atomizing carburetor the air and gas do not modify their speed of flow at the same rate under the influence of different depressions, inertia effects come in, and we find too much gas at high speeds and not enough at low speeds. With the usual type having a gasoline spray in an air tube, the jet will have a variation of flow depending on the speeds of gas and air flow. The relation of weight of air and gasoline will follow the variations of curve I. This curve is the upper one in Fig. 7. The inventor's



DIAGRAMS OF SOME NOVEL ACCESSORIES EXHIBITED AT THE TENTH ANNUAL PARIS AUTOMOBILE SHOW.

decided novelty, since it is intended to suppress the radiator entirely. Next to the motor is fitted a small apparatus whose section is shown herewith, and this cools the water by mixing it with cold air. The process is carried out by means of a pump which sends the water which is to be cooled into the jackets of the motor under pressure. When coming out of the water-jacket in a heated state, the water passes into a device consisting of two truncated cone nozzles, *BB*, shown in Fig. 4. These pieces are held and centered at the same time by a surrounding cylinder, *C*, and the whole is assembled by means of flanges. Owing to the conical shape of the nozzle, *B*, the water sent under pressure in the direction of the arrow takes a considerable speed, and, by a well-known physical

the inventors find it best to use at least three of the jets combined. This number will be found sufficient to thoroughly cool the water at all speeds of the motor.

AN IMPROVED TYPE OF CARBURETOR.

Among the new carburetors of which there were a number to be seen this year, is to be noted the Zenith, which is designed to secure a constant mixture. This is one of the problems which have occupied designers, and the desiderata to be realized are numerous, the most important of these being that the carburetion should be kept constant at all speeds and all inlet openings, and also that the fuel consumption should be low, that the motor should come up to speed quickly, and that it should run readily at slow speeds and be

idea is to add a second and compensating nozzle which will give a flow such that the relation of air and gasoline is in the inverse sense, as in curve II. The lower figures show the motor speed. If this condition is realized, and the two jets work together, they will correct each other, and the combination of the curves gives a straight line at all speeds, thus obtaining the constant flow which is desired.

From the second curve it is seen that the compensating jet should have a constant flow per unit of time, and that this flow should be independent of suction. Fig. 9 shows the section of the carburetor designed for this purpose. An ordinary jet, *G*, taking gasoline from *F*, has beside it a compensating jet, *H*. This second jet comes from the bottom of a tube, *J*, open to

the air at the top. The entry of gasoline into *J* is controlled by a determined orifice, *I*, which gives the flow into free air. The flow is determined only by the height of gasoline in *F*, which is constant in the float chamber as usual. As the section of *J* is much greater than *H*, pressure changes in the carbureter have no effect on the flow from *I*, and this latter gives the conditions of curve II. Fig. 8 shows the section of the carbureter, the two jets being concentric in practice. They lie in the chamber *S*, with the main jet in the center. The space *H* connects by *F* with the air-pipe *I*. At *O* is a small tube starting above *F* and ending at *U* against the side of the throttle valve, *P*, which can close it. Usually this tube has no action, as it delivers but little air, but in two cases it comes into use. First, on stopping, *J* becomes filled with gasoline, and thus the motor can start when much throttled. In fact the suction in *U* with the throttle nearly closed is strong, the small amount of gasoline in *I* is quickly drawn up, and the motor starts at the first revolution without the carbureter being primed. Second, when the motor works at no load and turns over very slowly, it needs but a small gas supply, and thus the suction around *S* is slight and not enough to draw all the gasoline out of *J*. Therefore it rises in the tube *J* until it meets the end of *O*, when it is rapidly drawn out and atomized at *U* because of the increased suction there when the throttle valve is nearly closed. At *K* is a wire-gauze for covering the end of *J*.

Besides the scheme of using two combined carbureters—a large and a small one for high and low speeds—another new development is a mechanically-operated needle valve which is let down into the spray nozzle from above when the throttle is closed (which creates more suction and makes too rich a mixture), thus throttling the superfluous fuel as it comes out of the spray nozzle. This arrangement is now fitted to



ELECTROLYTICALLY-FORMED COPPER HONEYCOMB RADIATOR SHOWN IN PARTIAL CROSS-SECTION

some of the leading carbureters of both French and American make.

NOVEL LOCKING DEVICE FOR STEERING GEARS, CHANGE-SPEED LEVERS, ETC.

The apparatus known as the "Autoloc" is designed to suppress the use of toothed sectors for levers in all parts of the chassis, along with the different pieces which they require, such as lock-pieces and springs. It also allows a locking and a non-reversible movement of clutches, speed-change levers, and steering gears, giving an easy and precise movement to these. The diagrams (Fig. 2) explain the operation of the device. First there is a fixed cylindrical box containing a cam, *B*, with double eccentric profile, forming inside the box a double crescent-shaped recess. Here are placed two steel balls, *DE* and *D'E'*, separated by compressed spiral springs, *FF'*. The springs keep the balls separated permanently at the ends of the space, so that they are blocked between the surfaces of the cam and the box. It is readily seen that the cam is blocked, since in order to move toward *D'*, for instance, it would compress the balls *D* and *D'*. Again, the balls cannot slide upon the surfaces owing to the angle of compression, which is mathematically determined. Thus the whole forms a rigid block. But if by the proper means we can displace the blocking system formed by the cam, balls, and springs, we have, at each point of displacement, the same result in the fixity of the cam. Suppose a cover or cap, *G*, having a handle, *H*, and carrying two lugs, *KK'*, and again the box above mentioned, but with a lever arm, *L*, solidly fixed to the cam by means of two riveted pins. In the cap, *G*, is a groove, *M*, whose width is slightly greater than that of the arm, *L*. Placing the cap upon the box, the lugs lie in the free spaces, *NN'*, and the lever arm is lodged in the groove.

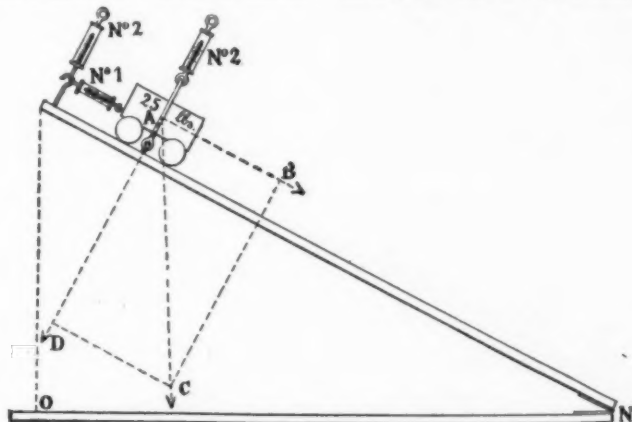
In this position of the ensemble, the whole being centered on the shaft, if we turn the cover by means of the handle, *H*, for instance from *E* toward *D*, the projection *K'* comes against the ball *E*, and also *K*

against *E'*. Continuing the movement, the balls are pushed into the wider space of the crescent, slightly compressing the springs, until the edge, *O*, of the groove, *M*, strikes the lever, *L*. Since the cam is freed by the movement of the balls, the arm, *L*, is carried along by the edge, *O*, of the groove, *M*, to the desired position. Thus the handle, *H*, can move the lever, *L*, around all the points of a circle in a progressive manner; but should the pressure cease on the handle, the springs react and drive the balls into the locking position, blocking the cam, and the movement is instantly stopped, no matter what may be the force or resistance applied on the arm, *L*, or in which direction it tends to turn it. It is clear, also, that the handle can be moved in either direction. The device can be made in any size to suit the kind of mechanism. One form has been designed for marine use which takes a pressure of 30 tons. At the same time the apparatus is not a large one. The system can be also made on a straight line form, as here shown, and this widens its applications.

A DEMONSTRATION OF THE DECOMPOSITION OF GRAVITY BY THE INCLINED PLANE.

By FRED D. BARBER.

ALMOST any plane suitable for use in laboratory work can quickly be prepared for this experiment. The writer uses planes made of 12-inch pine boards, 3 feet 6 inches in length. Two of these boards securely hinged at one end constitute the bed and plane. About three inches from the free end of the plane a screw hook is inserted in the center of the upper surface of the plane. Spring balance No. 1 is hooked over this hook and onto the car. Spring balance No. 2 is merely hooked into the screw hook. The instructor then lifts the plane by means of balance No. 2, always pulling at right angles to the plane. Balance No. 1 evidently gives the component of gravity which is parallel to the plane, while balance No. 2 gives the compon-



A DEMONSTRATION OF THE DECOMPOSITION OF GRAVITY BY THE INCLINED PLANE.

ent which results in pressure against the plane. As a quantitative experiment, or a merely relatively quantitative experiment, the arrangement described is sufficient.

If it is desired to make this experiment more quantitative, a screw hook must be inserted in the plane at either side and opposite the center of gravity of the car. The two ends of a cord may then be tied into the screw hooks and balance No. 2 hooked into the loop above the car. The slope of the plane, i. e., the height and length of the plane, may then be taken at the same moment that the reading of each of the balances is taken. These readings may be taken at as many different angles of the plane as may be desired.—School Science and Mathematics.

LIMITS OF DEEP-SEA DIVING.*

THE depth to which a diver can descend would appear to be limited by his power for withstanding the adverse influences acting upon him while carrying on his duties under water. Apparently a descent of thirty fathoms of water marks the limit of safety for even the few divers who possess the necessary physical fitness in combination with a disregard for danger beyond the average. Records in deep-sea diving have to be accepted with the proverbial grain of salt. It is said that a diver reached thirty-three fathoms and a half while engaged in salvage operations on the west coast of South America; and, yet again, another diver working on the same wreck is reported to have brought up three bars of copper from a depth of forty fathoms at the expense of his life. Captain Eads, while superintending his great work at the South Pass and on the Mississippi, found that very few men, whatever their build, are capable of combating the severe strain which is brought to bear upon their physical energies for a few minutes at a depth of twenty or thirty fathoms. Many of his divers dared not venture below ten fathoms. Of 352 divers employed at greater depths 30

were seriously injured, and the result was fatal in 10 instances. In 1885 the steamer "Alfonso XII." was lost off Point Gando, Grand Canary, with ten boxes of specie on board. The Marine Insurance Company sent out three divers, Alexander Lambert, David Tester, and F. J. Davies, who succeeded in getting up nine out of the ten boxes with their contents intact. Lambert was most successful, and suffered from paralysis of his internal organs in consequence, but appears to have recovered under skilled treatment on shore. In a subsequent expedition, sent out to recover the missing tenth box, Tester lost his life, presumably by remaining under water too long without returning to the surface. During the first expedition Lambert received \$20,000 and Tester about \$7,000, as they were paid regular wages, 5 per cent on the value recovered, and a bonus of \$250 a box. The depth was 160 feet, and the boxes of gold had to be won, at that depth, from a small lazarette in the ship's run to which access was obtained through three decks by the aid of tonite having an explosive upward force. A German company also had a try for the other box of \$50,000, working on the basis of 50 per cent, no cure, no pay, but the divers found the depth too much for them and the salvage was abandoned.

In 1896 a steamer bound from Australia to China went down with \$50,000 of gold in her. After a protracted search the wreck was located in twenty-seven fathoms, at a spot where the surface current varied in velocity from 1½ knots to 3 knots, and an even stronger set prevailed at the bottom. Two divers named May and Briggs essayed the critical task of wresting this sum from the domains of Neptune, and succeeded in sending up four-fifths of the amount after arduous labor, interrupted by spells of bad weather, which covered an interval of three months. The remaining \$10,000 had to be left below owing to the ship showing certain signs of breaking up at any moment. Having regard to the risk run, and the time occupied in the salvage, the sum of \$7,500 awarded to the two divers

was not excessive. One of the leading cases with respect to deep-sea salvage is that of the steamer "Skyro," which went to Davy Jones's locker off Cape Finisterre in April, 1891. On board of her were silver bars worth at least some \$45,000, and men's minds were exercised in devising plans to overcome the many and various difficulties of the situation. Several attempts were made during the ensuing five years, but nothing of more importance than the brass grating of the cabin skylight was recovered. Then came the hour, and the men. Messrs. Siebe, Gorman & Co. constructed a special diving-dress, Messrs. Moffatt got together the necessary plant and accessories, and diver Angel Erostarbe undertook the descents. Having recovered bars worth \$29,500 in two months, and the winter being at hand, operations were postponed. Next summer he recovered the whole of the remaining bars. On one specially lucky day he sent up twenty-two bars of silver worth \$11,000.

It appears that the diver is endangered by the permeation of the blood and body fluids with nitrogen. The distressing symptoms experienced in deep-sea divers' work are not due to the tremendous pressure, as hitherto understood, but rather to poisoning by carbonic acid, which creates a feeling of breathlessness and oppression. Coming to the surface too quickly, the diver feels the evil effects of the absorbed nitrogen acting on his system. With very special air-pumps divers went down to thirty-five fathoms in a Scotch loch, and were none the worse on returning to the surface exceedingly slowly. Messrs. Hill and Greenwood, of the London Hospital, consider that thirty-five to forty fathoms is the probable limit of deep-sea diving, even under scientific methods, as the supply of oxygen then required is so much in excess as to produce pneumonia, inflammation of the lungs, and convulsions. The personal experiments of Messrs. Hill and Greenwood, carried on for the benefit of mankind at great risk to their own lives, are worthy of the very highest commendation.

* Abstracted from Shipping Illustrated.

ELECTRICAL NOTES.

Thomas A. Edison has patented a method of making cylindrical containers for accumulators, of iron, by electroplating. The mold is a brass cylinder which can be turned about its vertical axis. It is first dipped into fused paraffin and covered with graphite, and then lightly coppered (0.04 inch thick) in an acid copper bath, and nickeled (0.001 inch). The iron bath contains up to 15 per cent of ferro-ammonium sulphate, free of ferric salt and of acid. Currents of 1 or 1.2 amp./dm.² act for 30 or 35 hours at 40 deg. C. to produce an iron deposit of 0.02 inch. The cathode mold is rotated at 90 revolutions per minute, and further to prevent pitting by gas-bubbles, about half as much charcoal as the bulk of liquid is added to the solution. About 0.4 per cent of carbon is taken up from this charcoal. Mold and deposit are then separated in hot water, the copper is dissolved out by means of copper nitrate or sodium nitrate, and the iron, together with the film of nickel, is heated in a hydrogen atmosphere, when the hitherto brittle iron becomes tough and is converted into steel, owing to its content of carbon.

The vicissitudes of a submarine cable are many, says the Magazine of Commerce. It may be torn by an anchor, crushed by a rock or seriously damaged by a coral reef such as abound in the tropics. Some of the growths often found on a cable tend gradually to decay the iron sheathing wires. Then, again, a cable is sometimes severed by a seaquake. It may be fatally attacked by the snout of a sawfish or by the spike of a swordfish. But perhaps the little animal that makes itself most objectionable from the cable engineer's standpoint is the insignificant-looking teredo navalis. This little beast is intensely greedy where gutta percha is concerned, working its way there between the iron wires and between the serving yarns. The silica in the outer cable compound tends to defeat the teredo's efforts at making a meal of the core and this defeat is further effected by the core being enveloped in a thin taping of brass. But where the bottom is known to be badly infected with these little monsters of the deep, the insulator is often composed of India rubber, which has no attraction for the teredo and possesses a toughness, moreover, which is less suited for its boring tool than the comparatively cheese-like gutta percha, which it perforates with the greatest ease.

In a paper read before the Verband Deutsch. Elektrotechniker, Hamburg, a meter was described which only registers when the current exceeds a certain limit. It is intended for use in cases where the consumer is charged a certain rental for a given current, irrespective of the number of hours during which the current is used. In order not to restrict the consumer in any way, he is supplied with the meter in question. It consists of a simple form of motor (whose field is formed by a permanent magnet), having its armature in a shunt circuit across the mains, and running at a constant speed. The motor drives through suitable bevel wheels, a spindle carrying an aluminium disk, against whose surface is pressed a small counting roller (geared to the counting mechanism). This roller is arranged to be movable, and is attached to the core of a solenoid traversed by the main current, so that as the current increases the roller moves radially outward along the disk, and its velocity increases. The roller is normally pressed against the center of the disk, and is maintained in this position by a detent and an antagonistic spring, so that it is pulled outward only when the current exceeds the normal value. The consumer, in addition to the fixed rental, is charged for the amount registered by the meter.

The newly projected electric railroad which is to be built between Milan and Genoa will be about 80 miles in length. According to the plans, there will be nineteen tunnels, one of which is twelve miles in length, along the tract. To supply the current for the road it is proposed to build an electric plant which will be one of the largest in Italy and will have a capacity of 25,000 kilowatts. It will be operated on the hydraulic system. As regards the railroad, it is to be double track, standard gage, the total cost of the work being estimated at nearly \$50,000,000. It is planned to run passenger trains of 150 (long) tons which will consist of three coaches of fifty places each and an electric locomotive of the double-bogie type. On the locomotive will be fitted four motors of 220 kilowatts each. The weight of the locomotive is 45 tons. About 75 miles an hour is expected as the highest speed upon a level grade, and 50 miles on the up-grades. The schedule is drawn up for twenty trains per day at the start of the line; and it is expected to run an express train at two-hour intervals. The traffic on the road is figured at 6,000 passengers per day, in addition to a large freight traffic. For the latter, the line will run 70 or 100 freight trains per day. Such trains will have 700 tons weight and will run at a reduced speed of 20 miles an hour, using thirty cars per train.

ENGINEERING NOTES.

The East Indian Railway intends shortly to put on corridor trains, built after the most approved American design, on the Calcutta-Bombay run, and eventually similar trains are to take the place of the present mail trains to Delhi and beyond. The new carriages, which are almost ready, are luxuriously upholstered.

The acting British consul-general at Hayti reports that the government of Hayti have ceded to the Compagnie Nationale des Chemins de Fer d'Hayti the railway already existing from Cape Hayti to Grande Rivière. This line is to be extended to Hinche, and thence to Port-au-Prince, with a branch to Arcahaie. It will be connected with the line which the same company is about to construct from Gonaives to Hinche.

Street railways with cars operated by manual power are in use at Mombasa, in East Africa. The light, narrow-gauge tracks are laid through the street, and the cars are for hire, like cabs, or are the private property of officials and wealthy residents. They are little four-wheel cars with one or two cross seats, and each is propelled by two natives. Spur tracks are run into private grounds, so that persons can take the cars to their doors.

Rails weighing about 120 pounds per yard are being tried on the Belgian State Railways. It is considered that the present 80-pound rails are not sufficiently heavy and strong for main-line traffic, in view of the great increase in weight of locomotives and carriages. Some 100-pound rails are in use, but mainly at turn-outs and crossings. With the new rails, heavier fish-plates are used, and the ties are spaced 20 inches to 24 inches center to center instead of 32 inches. The rails are all of the tee section.

It is convenient to remember, says Power, that if the charge taken in by a gas engine be compressed to one-sixth its original volume—that is, if the compression ratio be 6—the compression pressure will be ten times the pressure of the charge before compression. Thus, if the suction pressure be 13½ pounds absolute, and the compression ratio be 6, the compression pressure will be about 135 pounds absolute. This compression pressure is very often used in engines for operation on producer gas.

A fireclay mixture which is claimed to be suitable for standing high temperatures without cracking or checking may be made as follows: 45 per cent crushed firebrick, 50 per cent fireclay, and 5 per cent clean sharp sand, to be moistened and mixed to a heavy paste. For steam-tight joints use white lead ground in oil, to which is added as much as will work in of black oxide of manganese and a small portion of litharge. This is kneaded with the hand, the board being dusted with red lead. To use it, the mass is made into a small roll and pressed into position, the joint being first slightly moistened with linseed oil.

A description of the plant of the Colusa Parrott Mining and Smelting Company at Butte, Mont., states that the installation follows the general lines of the practice in steel mills, but that special means have to be taken for dealing with the dust and friable matters carried over from the smelting furnaces. The three smelting furnaces are of the reverberatory type, and are fired with coal. The waste gases formerly passed to the chimney-stacks with temperatures ranging from 1,500 deg. to 2,000 deg. C. This temperature is now reduced to 500 deg. C. by means of the new waste-heat boiler installation, and one tall single stack has replaced the three independent ones to each smelting furnace. The waste gases from the boilers are passed through a dust-settling chamber 50 feet wide by 19 feet high by several hundred feet in length before passing away up the chimney-stack. The boiler used with each smelting furnace is a 515-horse-power unit of the Worthington type. It is built with a central horizontal steam drum, with inclined banks of tubes, the steam drum being 42 inches diameter by 20 feet long. There are 61 sections of water tubes, each with 8 full-length tubes and one shorter tube connecting with the lower side of the drum, making a total of 549 tubes. The tubes are 10 feet in length by 3 inches diameter, and the total heating surface presented to the hot gases by each boiler is 4,635 square feet. Apart from its size, the boiler presents no unusual features except in the casing. This is of special design to permit of cleaning while in service, the entire outer casing being formed of hinged doors, of which there are two on each end and six on each side. The spaces between the tubes are kept free from accumulations of dust by slotted openings in the lower doors at both front and back, through which cleaning bars may be inserted. The slots are 2 inches by 10 inches in size, and are cut through the doors in line with the openings between the headers of the boiler. These slots are closed when not in use by small flap doors hinged and held by buttons on the main doors. The installation is stated to be successful.

TRADE NOTES AND FORMULÆ.

Blue Stain for Ivory.—Immerse in 1 part hydrochloric acid to 35 parts water for 2 to 3 minutes. Then immerse for several hours in 1 part indigo carmine in 6 parts of water.—Bersch.

Waterproof Shoe Polish.—A solution of 1/3 of an ounce of dark-colored shellac is made in 2 ounces of alcohol into which 3 grains of lampblack and 60 drops of train oil are stirred. Apply to the leather by means of a sponge.

Burning Pictures on Paper.—A solution of 40 parts of saltpeter, 20 parts of gum arabic, 40 parts of warm water tinted with aniline color, mixed and impressed on paper. If the impressed paper be brought in contact with a glowing body it will take fire and burn all the coated parts.

Diamond Cement for Glass.—(a) Isinglass 20 parts, water 140 parts, alcohol 60 parts. (b) Mastic 10 parts, alcohol 80 parts, gum ammoniac 6 parts. Fluids a and b are separately prepared, a by heating and filtering the solution. Both solutions are mixed and the powdered gum ammoniac only added at the end.

Iron Wire, to Make Silvery White.—Etch with muriatic acid, on which a piece of zinc is suspended. Then, in combination with a plate of zinc, place it in a bath composed of 2 parts by weight of tartaric acid dissolved in 100 parts by weight of water, to which 3 parts of tin salts and 3 parts of soda have been added. Polish after two hours.

Iron Wire, to Coat with Copper (according to Otte).—The wire is laid in dilute hydrochloric acid on zinc plates, the weight of which is 1 per cent that of the iron. After 2 hours, the iron will be lightly coated with zinc and should then be placed, for 5 or 6 minutes, in blue vitriol solution and finally passed once through the drawing iron.

Iron Wire, to Tin (according to Otte).—First galvanize as before. The wire is then connected with zinc plates and immersed in a fluid prepared as follows: 2 parts tartaric acid dissolved in 100 parts of water, 2 parts of tin salts, suspended in a linen bag in the solution, stir it until the precipitate disappears and add, in small quantities, 3 parts of soda. After 2 hours, the wire will be tinned and can be brightened by passing it once through the drawing iron.—Bersch.

Diamond Cement.—(1) 500 parts of Cologne glue is steeped in 400 parts of water with 100 parts of 96 per cent acetic acid for several hours; heat the mixture until solution is effected and finally add 1 (one) part of pure carbolic acid. (2) 16 parts of linseed oil varnish, 16 parts of litharge, 15 parts precipitated chalk, and 50 parts of prepared graphite. (3) 15 parts of precipitated chalk, 15 parts of litharge and 50 parts of finely powdered graphite and add enough linseed oil varnish to produce a plastic mass.

Putty for Floor Boards.—(a) 20 parts by weight of gelatine (or gilders' glue) dissolved in 160 parts of water. To this add a mixture of 60 parts of gypsum, 20 parts of fine sawdust, and 20 parts of yellow ochre. (b) 20 parts of glue or gelatine, dissolved in 160 parts of water, then 80 parts of hydraulic lime and 30 parts of finely sifted sawdust added. We may also use, in place of the gelatine solution, 500 parts by weight of caseine dissolved in 1,500 parts of hot water. Add 150 parts of spirit of sal ammoniac and after several hours stir in 750 parts of hot water and 130 parts of pulverized fresh lime.

To Etch Ivory.—Etching ground, 66 parts of white wax, 66 parts of mastic, 2 parts of asphalt, melted together. The design must be drawn with a graving needle. Etching fluid: 2 parts of pure silver, dissolved in 33 1/3 parts of nitric acid and diluted with 750 parts of distilled water. After etching, wash repeatedly in distilled water. After a few hours, wash out with oil of turpentine and carefully dry; the drawing will be black. For brown drawing, in place of silver solution, use a solution of 1 part of permanganate of potash in 16 parts of distilled water. The ivory must be absolutely free from fat.—Bersch.

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